CENTRAL RESOURCE ADEQUACY MARKETS FOR PJM, NY-ISO AND NE-ISO

Final Report

Prepared by NERA

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Disclaimer

Throughout this report opinions are expressed by using the terms 'we' and 'NERA'. We use these terms interchangeably to refer to the opinions and recommendations of the principal authors of this report Dr. Chantale LaCasse, Dr. Philip Kalmus and Mr. Eugene Meehan. Opinions and recommendations attributed to NERA are solely the opinions and recommendations of these authors and do not necessarily reflect the opinions and recommendations of any other individual at NERA and do not necessarily represent a consensus view of the firm.

The report contains recommendations on important aspects of a Centralized Resource Adequacy Market (CRAM). The recommendations are based on a thorough analysis of the capacity markets, auction theory, empirical evidence and on the use of numerical simulation models. The recommendations in our view best address the objectives of the Resource Adequacy Model (RAM) Group. The recommendations can however not guarantee the success of the market. Important issues such as the implementation of the auction format are outside the scope of this report, yet they have a material impact on the success of CRAM.

The recommendations in the report are designed to form a coherent program for CRAM. Rejecting a subset of recommendations may have a material impact on the validity of the remaining recommendations.

1. EXECUTIVE SUMMARY

National Economic Research Associates, Inc. (NERA) was retained by ISO New England, the New York ISO and the PJM ISO to conduct a comprehensive analysis of the centralized resource adequacy market model (CRAM) that was developed and proposed by the interregional Resource Adequacy Model Group (RAM Group). The proposal would establish centralized capacity markets that would operate in a coordinated way in the three ISOs. NERA retained and worked with Neenan and Associates, who advised NERA and the ISOs on issues related to demand resources and retail access.

The RAM Group proposal is driven by a desire to provide sufficient economic incentives for, and indeed to assure, resource adequacy. Resource adequacy is defined as having in place, a sufficient amount of resources measured in unforced capacity (UCAP), such that the expected loss of load probability is one day in ten years – a long standing regional reliability standard. This level of resources, relative to load, should result in an acceptable infrequent reliance on emergency operating procedures and avoid extreme upward volatility in spot energy prices that are unacceptable to energy market participants and governmental entities. The fact that at this level of supply, scarce supply conditions are very infrequent and upward price volatility in energy markets is muted means that a capacity market, or capacity requirement, is required. Energy and AS markets as currently structured and mitigated do not provide sufficient revenue to induce resources that will supply the desired level of resource adequacy.

A supplemental incentive to construct new resources and in some cases, continue to maintain and operate existing resources is needed to provide sufficient incentives for resource development and maintenance. This incentive could be provided in two broad ways. First, a capacity requirement could be imposed on load serving entities (LSEs) and LSEs would be required to assure that sufficient capacity was in place with sufficient planning lead-time. This is the model suggested by the FERC in its SMD NOPR. Second, the ISOs could act as a central buyer of capacity and make forward commitments to buy capacity that is financially supported by charges to LSEs during the capacity supply period.

The former model, requiring that LSEs make forward capacity commitment to ensure adequacy, is difficult to reconcile with a retail choice environment in which LSEs have no forward obligation or assurance that they will be serving any load, except as may be provided for in a contract with an end-use customer. All but one state in the region encompassed by the ISOs has full retail choice. The latter model, a centralized market model, is the direction chosen by the RAM Group.

The model specified by the RAM Group, the CRAM possesses an elegant simplicity. The ISO would determine the resource need in advance of the planning period, would hold a central procurement through an auction, would pay the auction price to all resource providers during the period and would recover the cost from load during the planning period. The difficulties arising from uncertainty with respect to load obligations several years in the future would be eliminated and all LSEs would face a common charge for resource adequacy that would be passed on to consumers and would be competitively neutral at the retail level. Consumers would receive the benefits of adequacy and pay the cost of adequacy. These features are the essence of the CRAM.

NERA was asked to examine several key features of the CRAM which were developed on a conceptual level, but on which no decision had been made. These key features were:

1. The planning horizon or how far in advance of the supply commitment the auction should be held.

2. The commitment period or what the length of the supply commitment or contract should be.

3. The percent procured which encompasses whether the ISOs should procure all capacity for a commitment period at one time or procure various percentages at different times, perhaps even with different planning horizons.

4. The auction format with a particular request to examine a descending clock auction, a Reverse English auction and clearing, versus pay as bid formats.

NERA was asked to examine all these questions relative to the RAM Group objectives and also to carefully consider gaming and market power issues; and monitoring and mitigation to ensure that the CRAM with NERA's recommendations would not be subject to market power. Implicit in NERA's charge was the need to conduct the economic analyses needed to fill in the CRAM, to test the CRAM and to provide an opinion as to whether the CRAM as supplemented by NERA's recommendation could meet the RAM Group objectives – i.e., whether the elegant simplicity of the model would hold up to further detailed specifications and analysis.

Further, NERA addressed several other items, which were labeled implementation issues. These included issues such as offer caps and deficiency charges, compatibility with demand resources, reconfiguration auctions, compatibility with a variable resource requirement (VRR) and compatibility with retail access and bilaterals.

NERA assembled a team of economists with many years of experience in electric markets and auction theory and implementation to address this project. The methodologies used by NERA consisted of a combination of the application of economic reasoning and modeling at all stages of the report. Planning horizon and commitment period issues were further analyzed using simulation models. Auction format and percent-procured issues were further examined by reference to the extensive theoretical and empirical literature. Each section of the report describes further the methodology used as outlined below.

In this report, NERA first provides discussions of the basic approach to its analysis. That is, after the Introduction (Section 2) the report focuses on the planning horizon and commitment period (Section 3), the percentage of the obligation procured (Section 4) and the structure of the central auction (Section 5). Section 6 focuses on the effect of deficiency charges should have on offer caps. After these basic design and parameter issues are discussed, NERA then addresses the compatibility of CRAM with a variety of key policy initiatives including market monitoring and mitigation (Section 7), Variable Resource Requirements (Section 8), retail choice (Section 9) and non-discrimination among resources (Section 10). Finally, Sections 11 and 12 discuss the impact of CRAM on energy and ancillary markets and how reconfiguration auctions are designed to "fill in the gaps" in capacity markets.

With respect to the major issues NERA reached the following conclusions:

1. The planning horizon must be sufficiently long to enable the CRAM to be a deciding factor in the decision to construct. Only when the CRAM is characterized by new units competing to win a contract to construct plant, will the CRAM meet the objectives of assuring resource adequacy and revealing the market price for adequacy. Further, the capacity market is in very much the same supply and demand balance as peak hour energy and distinguishing between prices that reflect economic scarcity and market power is difficult and contentious. Only when the pool of competitors is expanded to include entrants can market power concerns be adequately addressed. Practically, this means that a three-year planning horizon is the minimum.

2. Sequential auctions are not reliable for determining price and one hundred percent of the capacity required should be procured or under contract to be procured at all times. Auction research shows that sequential auction, where say, fifty percent of the requirement is bought at one time and the remainder is bought later in a subsequent auction, produces unpredictable results and would not provide meaningful price signals.

3. The commitment period could be from one to three years, but three years is preferable as it increases revenue certainty and is more likely to lessen the uncertainty facing bidders and remove uncertainty premia. A major issue in determining the price that is acceptable to an investor in a new plant is the expected future level of capacity revenue. While longer term (say, ten years) contracts would produce price offers not as affected by uncertainty, NERA did not believe that a central market could realistically impose long-term obligations on customers and considered three years as the longest acceptable

commitment period. Three years is consistent with the spirit of deregulated generating markets, which is not to impose long-term risks or customers.

4. An open auction format is desirable and the Descending Clock Auction (DCA) (a multi-round uniform price auction) is the best-suited format. Bidders face major common value uncertainties – in particular the potential level of energy and ancillary services (AS) net revenues and the uncertainty of post commitment period capacity revenues. Open multi-round auctions induce more competitive bids given substantial common value uncertainty. The DCA is also suitable for locational capacity requirements, for auction that allow for limited imports and exports and for a coordinated multi-ISO procurement. The DCA format makes collusion difficult and can be fine-tuned through control of information released and specific auction rules to deter market power.

5. Trust competition to discipline price. Mitigate or use an administrative price only when there is not adequate competition. Capacity markets have been marked by extreme volatility and periods of very low prices and very high prices limited only by an administered price cap or deficiency price. These types of markets do not provide a meaningful economic price signal. When competition is inadequate, mitigation and price caps are a necessity. However, in order to meet the objectives of the RAM Group, the market must be permitted to reveal the competitive price needed to assure adequacy without mitigation or administrative price caps. We address in detail proposed mitigation measures and price caps including an administrative price that we recommend be employed when there is inadequate competition. However, price caps and mitigation should be the exception and not the rule. The CRAM will only work if/when conditions are competitive; there is no mitigation and no price cap.

Throughout its research, NERA remained open to the possibility that it would provide the best possible analyses and recommendation on the issues left open by the RAM Group, but at the end of the day, may render an opinion that the CRAM was not a suitable tool for meeting the RAM Group objectives and we interpret our charge as requiring such a finding if we so believe that this is the case. We, however, do not find this to be the case. We believe that the CRAM is a market model well suited to the objectives of the RAM Group and entirely consistent with the current environment in the ISOs with respect to deregulation of generation and retail access. While our scope did not involve a comparative assessment of the CRAM against other market models, it is difficult to envision an alternative model that would better meet the RAM Group objectives.

We do, however, offer several caveats concerning the CRAM and believe that these caveats should be recognized before proceeding. First, a premise of the CRAM is that the commitment period will not be so long as to transfer the long-term resource decision and capacity market risks to customers. These risks will reside with resource providers. It is unrealistic to expect that price can reflect life of resource amortization periods when contractual commitments to resource providers are shorter. Market participants must recognize that absent long-term contracts, which are always an option in bilateral markets, prices will need to reflect the competitive view of long term market risks and prices will likely exceed fully amortized capital costs offset by expected energy and AS net revenues. If this unacceptable, an alternative to the CRAM is needed.

A second caveat is that the current short-term residual capacity markets are not at all representative of the prices that would occur in the CRAM, and importantly, market participants must understand this for the CRAM to produce acceptable results. This caveat is stated to address concerns both from resource providers and buyers of capacity. With regard to the former, resource providers have expressed strong concerns that when the market has any non-trivial level of surplus capacity, capacity prices will collapse. We find it difficult to agree with this premise and we believe that with moderate surpluses, there will be a sufficient volume of capacity with high enough going forward costs to prevent a collapse and/or sufficient pricing power resulting from the level of concentration to cause prices from collapsing to low levels. We do not believe that the current short-term residual capacity markets are at all representative of the prices that would occur in the CRAM. Our economic reasoning and modeling both support this conclusion. However, if bidders initially base their offer decisions on expectations that are inconsistent with these findings, then market outcomes may at first be different from our beliefs of what the market equilibrium will be. Thus, a reasonable level of confidence in the market and its price signals is needed for the CRAM to produce acceptable results. There may well be a dislocation between the expectations of load and resource providers until actual market experience demonstrates the price levels that will prevail when capacity surpluses develop.

Finally, there are a variety of next steps and or further research that could be done to enhance the probability of success of the CRAM. At a minimum detailed business and auction rules would need to be developed. Credit and qualification criteria that are consistent with the CRAM as recommended herein will need to be integrated with the model. To the extent feasible, experimental tests of the auction format could be conducted. Most importantly, however, the major hurdle facing CRAM implementation is establishing market confidence in the model and in the application of monitoring and mitigation. The commitment periods do not provide a sufficiently long term to amortize capital over what is generally considered to be a period that produces acceptable prices. We believe that after experience is gained with the model and a pattern of prices is established, greater weight would be given by suppliers to post commitment period revenue opportunities and consumers would be more willing to accept price levels that would reflect the need to offset lower revenues during periods of excess supply with higher revenues when capacity is needed. The most difficult step will be the transition to the CRAM and the largest challenge will be to gain confidence of all parties in the workability of the model and the willingness to accept transitional results that may be less than ideal. In this regard the most important next step is to develop a consensus of market participants willing to move forward and make the model work.

2. INTRODUCTION

ISO New England, the New York ISO and the PJM Interconnection retained National Economic Research Associates, Inc. (NERA) to conduct a comprehensive analysis of the centralized resource adequacy market model (CRAM) proposed by the interregional Resource Adequacy Model Group (RAM Group). This proposal would establish centralized capacity markets that would operate in a coordinated way in PJM, the New York ISO and the ISO New England.

The three ISOs are fundamentally concerned that existing energy and capacity markets may not provide the needed economic signals for the maintenance of installed energy capacity, for the construction of new capacity as needed, and for the participation of demand resources. For resource providers, future energy market revenues are inherently uncertain and expectations of such revenue may not be sufficient to ensure that new investment is timely. Supply constraints mean that revenue is expected to be high for typically only a small number of hours. In some of these hours the prices may be capped or mitigation measures may be in place that prevent prices from reaching true market-clearing levels needed to attract investment in resources. The volatility of the capacity price in existing capacity markets has done little to compensate for the uncertainty in energy market revenues. In these existing capacity markets, capacity is typically purchased for a short duration and only a short time before it is needed. Existing markets may lead to inefficient decisions regarding the timing or the size of investment for new plants. In turn, under-investment or late investment by resource providers may have serious repercussions for prices paid by consumers.

The proposal for a resource adequacy model is meant to provide economic signals that are directly meaningful to the investment decisions of generators and to the decisions of demand-side resources. These economic signals are meant to lead to socially efficient decisions on new investments, on maintenance of existing capacity and on demand response.

2.1. Objectives of the CRAM

The RAM group has set forth a proposal by which the three ISOs will use a centralized market model to improve upon existing market arrangements. The objectives of the proposal as defined by the RAM Group included:

- Develop a model to acquire resources that assure adequacy and can be applied consistently in each region through a single commodity (unforced capacity);
- Address lead-times needed to develop and construct new generation and develop and implement demand response programs, through the appropriate planning horizon and commitment period;

- Create a market process that will reveal the appropriate signal for market adequacy, and minimize market power and gaming opportunities;
- Accommodate market entry for all market participant types and retail load switching for LSEs; and
- Support the development of a competitive wholesale marketplace for energy and ancillary services.

This proposal must be refined with a more detailed auction structure that would have as its main objectives:

- To provide sufficient economic incentives for resource adequacy;
- To provide meaningful economic price signals that encourage rational economic decisions; and
- To provide a full and fair opportunity for all possible sources of resource adequacy – supply, demand and transmission – to compete.

The auction structure proposed must also:

- Accommodate the individual State's retail choice implementation initiatives, especially with regard to promoting retail customer choice and switching;
- Provide for a self- supply or bilateral option;
- Provide as few opportunities for gaming as possible.

2.2. Description of the Proposed CRAM Model

The interregional Resource Adequacy Model Group (RAM Group) developed the main elements of the CRAM model, which became the starting point for NERA's work. These main elements are as follows:

- ISO forecasts the load and establishes an unforced capacity obligation for the future-operating year (defined as a June-May period) of a region / locality.
- The commitment of resources to meet the unforced capacity obligation is up to several years in advance of the operating year (say, for example, 3 years in advance of the operating year) through a centralized auction.

- Each ISO conducts its own separate centralized auction; however, the timing of the auctions will be coordinated. ISOs with locational requirements may conduct separate auctions for each location.

- Participation in the centralized auction is voluntary.

- Products that resource providers can offer into the centralized auction include: existing generation; planned generation; bilateral contracts for capacity resources; load management products, and, if applicable, transmission upgrades.

- Bilateral transactions are intended to be an integral part of the market to permit LSEs to self-supply their own generation or as a way for an LSE to hedge against a potentially higher resource price in the centralized auction. Resources obtained through self-supply or bilateral contracts must be offered and selected in the centralized auction to be counted toward meting an LSE′s resource obligation, and thus provide a hedge against the resource price determined in the centralized auction.

- The centralized auction-clearing price would be the price charged to all LSEs serving load during the operating year.

- The resource provider that offered and cleared MWs through the centralized auction would receive the centralized auction-clearing price for their cleared MWs during the operating year.

- Reconfiguration Auctions may be held periodically to allow resource providers to cover changes in their capacity positions that may result from unit cancellations, shutdown of existing facilities, or variations in forced outage rates, but would not change the price charged to LSEs serving load during the operating year.

- Deficiency charges will be assessed during the operating year to those resource providers that fall to actually provide the capacity commitments made through the centralization.

While these market design parameters are presented at a high level, it is clear that their intent is to develop a centralized auction process in which all capacity must be offered though the auction process in order to qualify as capacity, in which the costs incurred by the ISOs to acquire such capacity will be recovered through charges to LSEs serving load, and in which participation is voluntary by resource providers. NERA assumed that these key features of the market model were cast in stone.

2.3. Scope of Assignment

ISO New England, the New York ISO and the PJM Interconnection retained NERA to conduct a comprehensive analysis of the centralized resource adequacy market model (CRAM). NERA was specifically asked to determine if that model produces the desired market objectives, to identify any potential market flaws, and to identify market gaming and market power issues. As part of the scope, NERA was charged with providing recommendations on the following major issues:

1. Planning horizon and commitment period – these refer to the length of time between the conduct of the auction and the beginning of the capacity supply commitment and the length of the capacity supply commitment period, respectively.
2. Percentage of obligation to be provided in the centralized auctions – this refers to the amount of the obligation for any given year that would be purchased in a centralized auction. For example, if one centralized auction in 2005 procured all the capacity obligation for 2007, 100 percent of the obligation would be procured. If one auction in 2005 procured half of the requirement for 2007 and a subsequent auction in 2006 procured the other half, each auction would procure 50 percent of the obligation.
3. Structure of the central auction – NERA was asked to consider three specific auction structures, ***Reverse English***, ***Descending Clock***, and ***Receive as Offer***. Further, NERA in its proposal response, agreed to identify and examine other auction formats that held promise. As part of this task, NERA was asked to examine which auction format was best suited to minimize the potential for market power and whether a Variable Resource Requirement (VRR) would have beneficial effects under the various auction structures.
4. Deficiency charges and offer caps – NERA was asked to make recommendations on the issues of deficiency charges and offer caps.

In addition to these highlighted major issues, NERA was asked to examine five additional specific issues. These issues are as follows:

1. Market Monitoring and mitigation – NERA was asked to identify the market monitoring and mitigation measures that may be necessary to prevent any market participant from exercising any potential market power and/or gaming techniques.
2. Absence of discrimination – NERA was asked to consider and identify if any option results in a market structure that is unduly discriminatory to any market participant or contrary to market entry for any market participant type and retail load switching for LSEs.

3. Bilateral Market – NERA was asked to consider and identify the potential impact of the proposed centralized resource adequacy market on the bilateral market for capacity resources.
4. Effects on energy and ancillary services markets – NERA was asked to consider and identify the potential impact of the proposed centralized resource adequacy market on each region's energy market and ancillary services markets.
5. Reconfiguration auctions – NERA was asked to consider and identify if an ISO-administered Reconfiguration Auction in each region has any potential positive or negative impacts on the desired market objectives.

2.4. Important Elements Outside NERA's Scope

There are three very significant issues that are outside of NERA's scope. These issues are as follows:

- Qualification requirements – specifically, how does a resource receive an unforced capacity rating and what are the qualification requirements for existing generation plant, new generation plant, existing demand resources, new demand resources and planned transmission upgrades? NERA addresses herein the implications of qualification requirements on the CRAM proposal, however, the ISOs are expected to address qualification requirements.
- Credit requirements – specifically, what credit support is required to assure performance and what the cost impact of various levels of credit support will be on auction prices. Again, while NERA will recognize and discuss the importance of these issues, the ISOs are expected to address credit issues.
- Capacity interchangeability – specifically, the ability of capacity in one ISO to be qualified and bid in an auction in another ISO. The ISOs are expected to address this issue. For purposes of this study, NERA has assumed that capacity is interchangeable within the limits of interconnections.

We regard these features outside of NERA's scope as critical for the success of CRAM. In the report, we needed to make some assumptions regarding decisions that were not within the remit of the NERA study.

We would also like to stress that while we give recommendations on all issues required by the RFP, those recommendations do not translate directly into workable business rules that can be applied without a careful implementation project. The implementation of market recommendations can be just as critical to the success of CRAM as the recommendations themselves. In particular, no auction format can be successful if requirements for participation are too onerous for potentially interested parties or if the rules are too cumbersome to understand.

2.5. Overview of NERA's Approach

NERA's approach to the project can be summarized as a focus on economic incentives. NERA divided its analyses into three major categories. These are:

- Product Design – product design encompasses the key issues associated with determining "what" is being purchased. In the context of the capacity auction, these issues are the planning horizon and commitment period. Product design also covers some of the key issues being addressed by other groups such as qualification requirements and credit requirements. With respect to product design, NERA examined how the economic and cost structures faced by resource providers would interact with the economic incentives resulting from alternate product designs and what elements of product design would result in economic incentives that ensured that the CRAM objectives were met.

- Auction Design – auction design refers to "how" the capacity procured in the auction is acquired. It encompasses the auction format as well as consideration of the variable resource requirement and percentage procured. Auction design examines economic bidding incentives. As such NERA's auction design analysis examines how the auction format decision affects the economic incentives for bidding, how it influences the level of the CRAM clearing price, whether the format selects the most efficient resource providers and how susceptible it is to the abuse of market power. There exists a large body of academic literature on the economic incentives and empirical results for auction design issues and NERA has extensively researched that literature and applied it to the circumstances faced by the ISOs.

- The Product Design is linked to the Auction Design through our recommendation on the timetable of procurement, the "Percentage Procured". The planning horizon and frequency of CRAM auctions are important parameters both of the auction design and the product design. The product design is ultimately memorialized in the contract between the ISO and the capacity provider.

- Other Issues – the other issues that NERA was asked to examine embody a combination of issues related to economic incentives as well as practical institutional issues. For example, the extent to which the model facilitates bilaterals and self-supply is a practical issue while dealing with the requirements of demand response programs is both a practical issue and an issue having to do with economic incentives.

2.6. Summary of NERA's Recommendations on Key Items

2.6.1. Planning Horizon and Commitment Period

NERA recommends a planning horizon that is sufficiently long to enable the outcome of the auction to be known with sufficient lead-time to close financing and initiate construction that can be completed by the beginning of the supply period. Three years should be sufficient in most locations. This is needed in order to enable entry to discipline price and to assure that auction results in resource adequacy.

2.6.2. Commitment Period and Percentage Procedure

NERA recommends a three-year commitment period and an initial or transition auction for one-third of the total requirement for one-year commitment period, one-third for a two-year commitment period and one-third for a three-year commitment period. Subsequent auctions would be held each year for roughly one-third of the total requirement. At the time of any auction, roughly two-thirds of the total requirement for the first year of the upcoming three-year commitment period would be under contract and roughly one-third would be being procured in the auction. This three year commitment period and rolling procurement would provide three years of capacity revenue certainty to bidders, would provide an annual price signal, would assure that 100 percent of the capacity requirements is at all times either under contract (or under contract and being procured) and at the same time would not expose customers to the risk of transient events by buying all capacity for a period at one time.

2.6.3. Auction Format

NERA recommends a descending clock auction. We believe that, due to the infrequency of the CRAM auctions and the long time horizons of the planning and commitment periods, the key concern for bidders in the auction is a lack of information regarding the true value of capacity in the future. An open auction assists bidders in their decisions by revealing information through the auction process. Bidders can revise their valuations and bids during the auction. The open auction will lead to a more precise and therefore more informative price signal that reflects the value of capacity.

An open auction has other advantages: an open auction is the only format that can accommodate multiple products in the sense that it allows bidders to switch from one product to another product in response to changes in relative prices.

Amongst open auctions, we think that a descending clock auction is most appropriate for its simplicity for bidders and the good empirical competitive record in auctions in which participation was sufficient. A descending clock auction also makes monitoring during the auction and the analysis of bidding behavior after the auction feasible.

2.6.4. Market Monitoring and Mitigation

The objective of NERA′s recommendation on all aspects of the CRAM is to maximize the extent to which competitive forces can be relied on to produce a market price for capacity and to minimize the need for mitigation. NERA has recommended a three-year planning-horizon and Descending Clock Auction Format, because they facilitate competition. Competition among new units can be expected to discipline price and reveal the market price for adequacy. NERA recommends that competition be assessed at the qualification stage from the auction and that mitigation measures including a reserve price be employed in cases where there is insufficient competition. In cases where there is sufficient competition, NERA recommends that price not be capped or mitigated, but that the market reveal the price needed to attract new entry.

3. PLANNING HORIZON AND COMMITMENT PERIOD

3.1. Overview

The principal product design issues within NERA's scope are the issues of planning horizon and commitment period. The specification of the CRAM model has already set forth many of the product design issues. The product design elements of the model include the following:

1. The product will be unforced capacity and each resource will need to obtain an unforced capacity rating through an ISO conducted qualification process;
2. The commitment period will run from at least June through the following May;
3. There will be credit requirements and penalties for non performance; and,
4. Unforced capacity will only be recognized towards meeting the region's unforced capacity requirements if it meets ISO qualification criteria and is offered and cleared through the auction.

In order to complete the product design NERA was asked to make recommendations on the Planning Horizon and Commitment Period.

3.2. Planning Horizon

3.2.1. Economic Reasoning

The planning horizon is the most fundamental of all aspects of the product design. Specifically the choice of planning horizon will determine whether resource owners will need to make an entry decision prior to participating in the auction. This will further determine the economic incentives that will drive how resource providers bid in the auction and the degree to which competition from new entrants will act as a discipline on market price.

Planning horizons that require resource providers to make construction commitments prior to participating in the auction have distinct implications for the ability of the CRAM Model to meet the objectives set forth by the RAM group. Specifically, a planning horizon of this nature would limit competition in the CRAM market to those resources that have made the commitment to construct capacity before the auction was held. This limitation would be expected to have the following implications with respect to the CRAM objectives:

1. The market and auction process could not be counted on to assure adequacy as the maximum potential supply would be determined by entry decisions made outside of the CRAM process. If insufficient capacity were under construction there would not be a

remedy as the lead-time needed to construct new capacity would not allow for capacity to be developed in time.

2. The market process would most likely not reveal the appropriate price signal for market adequacy. This is the case because there are two possible outcomes. The first is that there is insufficient capacity and the only limit on price would be a price cap. The second is that there is surplus capacity and that new entrants having committed to construction and facing low incremental costs become price takers. As result the auction would clear based on competition among existing resource owners at prices that reflect a capacity surplus despite the fact that new resources were in fact required to meet the capacity need. This has the potential to result in extremes and volatility in the capacity clearing price, to result in price signals that are not economically meaningful and to result in a market that does not meet the objective of revealing the appropriate price for resource adequacy, which in a situation where new capacity is required is the price needed to induce entry from new resources.

   In reaching these conclusions, we are not asserting or assuming that the price set by existing resources competing in the auction in conditions of surplus capacity would necessarily be “very low”. While existing capacity markets have had a tendency to clear at extremes of the price cap under shortage conditions or to clear at very low prices with any surplus of supply, as we address later, there are significant differences between existing capacity markets and the proposed CRAM model. The clearing price of an auction held in a condition of surplus capacity with new units committed and acting as price takers will depend on many factors including the structure of the auction, the planning horizon and the commitment period. Additionally the price will depend on the incremental or going forward costs of existing capacity, which may be as high or higher than the cost of entry, the degree of concentration in the ownership of capacity and the nature and effectiveness of market monitoring and constraints, if any, upon bidders offer strategy. Hence, the point is not that the price will not be meaningful because it is too low, but that it will not be meaningful because the new units under construction will be acting as price takers and not revealing the appropriate price for resource adequacy. In the longer term this could well lead to situations where adequacy cannot be maintained because insufficient capacity enters construction.

3. The market process would not minimize market power and market gaming opportunities. Specifically, the potential for entry would no longer exist and entry would not serve as a disciplining factor on offers. This is contradictory to the stated objective of minimizing market power and gaming opportunities.

In contrast a planning horizon that was sufficiently long to allow for the results of the CRAM auction to be known prior to the decision to construct has the potential to meet the objectives of the RAM group. Specifically this would enable the following:

- The CRAM model would better ensure adequacy as the results of the auction would provide an incentive to commit to construction of resources and the ISOs would with sufficient lead-time procure capacity to meet the need that was contractually committed to construction and faced financial penalties if it failed to construct.
- The CRAM model would produce a more meaningful price signal when new capacity was needed as competitors to build new capacity would be able to bid based on the price needed to induce them to proceed with construction. This should reveal the appropriate price signal for resource adequacy.
- The CRAM model would have a lower exposure to market power and gaming opportunities as new entry would be available to serve as a discipline on market price.

The economic reasoning above led us to conclude that in order to be consistent with the objectives set forth by the RAM Group, the planning horizon should be greater than the time needed to construct a new unit.

3.2.2. Model Analysis

The economic reasoning was tested with a model that simulated market outcomes and resource entry decisions for various planning horizons.

The criteria that we examined with the model for evaluation purposes relative to planning horizon are as follows:

- Efficacy in ensuring that adequacy is maintained. This means that the planning horizon must be sufficient to enable the market to provide adequate resources.
- Convergence between the scenarios where the market clears based on cost-based bids and where the market clears assuming a Cournot solution or at a price cap.[1] This convergence indicates a reduced need to rely on price caps and to mitigate offers.
- Ability to achieve least cost mix of capacity over time. In particular, does the planning horizon preclude an alternative that would have been viable with a different planning horizon.

- Meaningfulness of price signals. This evaluates whether the market price for capacity has an economic content that reflects meaningful resource decisions.

The essence of the simulation model is to simulate entry by new resources in response to planning horizons that range from one to five years. The approach that we take is to treat the development of capacity as a probabilistic value. The problem facing developers is that the profitability of their plant investment depends upon how many others enter. If entry is very limited, those that enter will see high profits. If there is surplus entry, profits will be depressed. While developers will all have individual views of the market and profitability, the actions of competitors is one of the factors, and probably the most significant factor, that affects profitability of new entrants. This can be witnessed from the financial distress among generators as a result of the current capacity glut in many regions of the country.

There are economic theories for entry predictions under these situations. Each entrant's probability of entering is a function of the profits if they enter and others do not enter less the losses if they enter and others enter. As profits and losses may be asymmetric these probabilities can be such that, on an expected value basis, they will produce less entry than required, just the right amount of entry or too much entry. It is impossible to definitively determine the proper function. Hence we have tested the three possible situations above. We model entry that will occur outside of the auction as a function of the expected capacity shortfall. We assume ten potential entrants and assume in the first case that the entry probability is set to exactly produce the right level of entry on average. In the second case we assume that the entry probability is fifty percent below that needed to exactly produce the right level of entry on average. In the third case we assume that the entry probability is fifty percent above that needed to produce exactly the right level of entry on average. These probabilities are uncertain and will of course change over time. For example, when long periods of losses are experienced, developers may be less likely to enter. After shortages have occurred developers may be more optimistic and more likely to enter. While we cannot be certain of the exact probabilities we can be certain that in fact entry decision in the electricity generation industry and other industries do in fact exhibit the cyclicality implied by the probabilistic representation we are using.

Hence, the model recognizes that even with a one-year planning horizon, there is a probability of adequacy, as sufficient competitors may elect to develop. As the horizon is extended to five years, there is virtually complete assurance of adequacy as we assume that five years provides entrant sufficient time to win in the auction, initiate and complete setting and permitting and constructed capacity. With a three-year planning horizon, we see that entry into the

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[1] The Cournot solution or "equilibrium" yields a market outcome in which firms often restrict their quantities resulting in market prices that are above costs.

development stage is required two years before the auction, and is with a very high probability sufficient to result in an adequate pool of competitors in a three-year planning horizon auction and ultimately in supply adequacy.

Auctions with a three-year planning horizon provide projects that had entered into preliminary development an opportunity at the three-year mark to base the decision to proceed with major construction expenditures on their success at the auction. The model showed that; as capacity revenues were key to profitability, auction winners would proceed and auction losers would not. This led to a much tighter band around the reserve targeted and the reserve achieved. This provided for adequacy and also limited capacity and energy and AS price volatility. A key factor driving these results is the assumption that three years is a sufficient period to close financing and complete construction.

A key assumption in the modeling above is the formulation of the probability for entry. As discussed above, we tested two alternate probability functions, one that increased the likelihood of entry and the other that reduced the probability of entry.[2] As one would expect when the probability of entry was increased, it became less likely that there would be capacity shortages with shorter planning horizons. However, shortages were still far more likely than with a planning horizon that allowed for a planning horizon sufficient to permit entry as a consequence of winning at the auction. In this case there were more instances of excess entry (relative to the need) and protracted periods of excess supply and low capacity prices. As one would expect, when the probability of entry was lower there was an increased probability of not having sufficient capacity as the lead-time was reduced. This also resulted in a greater propensity to clear at the price cap. In this case it was far less likely that there would be periods of excess capacity and likely be prolonged periods of high prices. While for modeling purposes we treated the entry probability function as constant, it is more likely that it would fluctuate in response to cyclical conditions. In particular to the extent that the market had experienced a long period of excess, the entry function would incorporate lower probabilities of entry. To the extent that the market had experienced periods of shortage and high prices, the entry function would incorporate higher probabilities of entry. Had we modeled these cycles, the volatility would have been even greater. In sum, consideration of alternative probabilities of entry did not change any of the conclusions from the modeling analysis.

We also tested an alternative supply curve for existing capacity. The alternative supply curve, posited a significant portion of existing capacity (from ten to twenty percent) as having net costs that approached the assumed cost of entry. We tested this case, because given the advanced age of many generating plants in the ISOs and the potential that in the future there may be added

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[2] In the case where the probability of entry was lower it was less likely that there would be excess capacity and prices were higher.

environmental compliance costs for older plants, our assumption that existing generating units had going forward net costs that were far below new plant net costs could well be wrong. We found that this case did not change our conclusion that in order to assure adequacy the planning horizon needed to be sufficiently long to accommodate the construction of new generation. Under these assumptions however, there were decreased problems with respect to downside price volatility -- i.e., prolonged periods of low prices that may discourage future entry – and with market power concerns. The cost-based bidding and Cournot solutions to the market tended to clear much closer together primarily because the cost-based price was significantly higher in conditions of moderate capacity excesses.

3.2.3. Developing Recommendations Based on the Economic Reasoning and Modeling

The clear conclusion drawn from the economic reasoning and modeling is that in order to meet the objectives of the RAM Group, the planning horizon had to be long enough to permit the construction of new generating units. In order to translate this in to practical recommendations, we further considered the issue of the difference between committing to construction and to committing to development. The former involves a decision that generally encompasses ordering equipment, entering in to an engineering, procurement and construction (EPC) contract and closing financing. These actions set in motion the expenditure of a large amount of investment funds (in the hundreds of millions of dollars for a single unit) and cannot be reversed except at high cost. The latter, committing to development, generally requires obtaining a site or site option, permitting and expending development funds to be able to take the next steps. These activities, while possibly entailing costs in the millions of dollars, can potentially be partially salvaged by holding them for future use in the event that development activities do not result in a winning bid in the CRAM auction.

To the extent that the planning horizon was set to allow sufficient time for construction, but not for development, there exists a risk of inadequacy if insufficient units elect to enter the development stage without assurance of winning in the CRAM auction. There also exists a risk that entry will be insufficient to ensure vigorous competition in the auction and have entry act as a disciplining factor on auction results. Holding the auction at this stage does, however, make it possible that qualification requirements be set so that there is a very high likelihood of achieving development as by this time it can be expected that siting and permitting issues have been arranged and that arrangements for financing and an EPC contract are in place awaiting auction results. Further, with development certainty greater, bidders would be more likely to agree to post more security.

In contrast, holding the auction at the development stage poses a different set of risks to adequacy. Qualification requirements would need to be less stringent as plants at this stage would be expected to be less along in their development. The chances that development was not achievable would be greater and bidders would be less willing to post security or would require significant premiums in the price. While it may be possible to procure later for plants that fail to develop, allowing for this would pose gaming issues and given that the planning horizon was set at this level, there would likely not be sufficient new capacity in development that was not committed through the auction.

In consideration of the above, NERA recommends that the planning horizon be set with sufficient time to allow for the construction and financing of new capacity and that qualification requirements be set to require that new generation is in advanced stages of development and has made significant progress on siting and permitting issues and has few, if any, impediments to closing financing and completing construction.

We recognize that this will only meet the RAM Group objectives to the extent that developers are willing to take development risk on a speculative basis. We believe that it is reasonable to believe that they will. More importantly this development risk cannot be reduced by either shortening or lengthening the planning horizon. A shorter horizon would increase speculative risks because plant development would have to begin before developers were assured of the specific need for their capacity. If developers are intolerant of this risk, a shorter horizon could make it more difficult to achieve adequacy. A longer horizon would increase the probability that capacity that was relied on was actually not able to be developed and would also make it difficult to achieve adequacy.

On a practical basis, this recommendation translates to a planning horizon of three years. Three years should provide a sufficient amount of time for a large-scale new combustion turbine combined cycle plant to be financed and constructed. To allow for a margin of safety, the auction could be held between October and March for a start date that is three years from the following June, effectively allowing for a planning horizon of three and one-half years. (Note the process will need to start earlier as several months may be needed to determine the need for capacity.) The three-year recommendation will need to be reviewed by each ISO to ensure that it allows sufficient lead-time for local conditions. Further, the principal recommendation is that the planning horizon be longer than the lead-time for the units likely to be added[3]. The practical recommendation for three years is a secondary recommendation that will need to be periodically examined to make sure that is in line with this principle recommendation.

In formulating its recommendations on planning horizon, NERA, in addition to considering the economic theory and modeling, also considered the results of surveys of generation developers and financial institutions and of demand response providers as well as the feedback from market participants. As this feedback was on both the issues of the planning horizon and

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[3] A two-year planning horizon could achieve adequacy by relying on smaller scale short lead-time units. These units would, however, be more costly and results would be less efficient.

commitment period, it will be discussed at the conclusion of this section with respect to both issues.

3.3. Commitment Period

3.3.1. Overview

The second critical product design issue that NERA was asked to examine is the commitment period or the length of the contract awarded to winning suppliers of capacity at the auction. The RAM model assumed a one-year commitment period and NERA was asked to examine and make a recommendation on the issue of commitment period. Again, NERA focused on the economic incentives associated with alternative commitment periods and the ability of alternative commitment periods to meet the objectives of the RAM Group. This task also involved a logical economic examination using economic reasoning and modeling to test that reasoning and guide recommendations.

3.3.2. Economic Reasoning

The commitment period defines the length of the contract to be awarded. The principal economic function of the contract is to apportion risk between the consumer and the provider of capacity. While the ISOs will run the auction process and will act as the counterpart to the contract and while the credit support for the contract will come from charges made to LSEs in order to pay the costs incurred by the ISO in connection with the auction, the ultimate consumers of the capacity bought at the auction are the end users of electricity. The term of the contract – i.e., the commitment period – serves a basic function -- to allocate a specific risk, the risk of post contract market conditions, between providers of capacity and end use consumers.

The risk of post contract market conditions encompasses many items. These include the following:

1. The risk that there will be surpluses or shortages of capacity when the contract expires;
2. The risk that technological changes will increase or reduce future auction clearing prices relative to those anticipated at the time the auction closed;
3. The risk that input costs (equipment costs, fuel, costs of debt and equity) will rise or fall;
4. The risk that the market structure will be significantly altered; and,
5. The risk of regulatory interference with the market or of intervention by the ISOs to mitigate prices in future auctions.

The allocation of risk and specifically of this risk of post contract market conditions is critical in that it affects the price that will be demanded by those developing new units. Capital is not yet committed to new units and will only be committed to the extent that the auction price in combination with the post contract market risks are seen to provide an acceptable opportunity for profit.

In formulating the minimum offer that a provider of new capacity could make, the starting point is the investment cost of the unit. There are three sources from which the revenue to recover these costs comes. The first is revenue from the capacity auction for the duration of the commitment period. This revenue is reasonably certain. The second is revenue from energy and ancillary services (in excess of variable costs of providing these services – energy and AS net revenues), and the third is expected revenues from future capacity markets. (Note: The prospect also exists of selling energy and AS and future capacity in bilateral markets. One would expect that prices in ISO markets for these services would set the expected revenues that would be garnered from bilateral transactions.) These revenue expectations, after discounting at a rate that provides for a risk-adjusted return on capital, must exceed the investment cost in order to induce investment. Competition in the market would drive the amount by which the discounted value must exceed the investment cost to near zero.

The residual value in this equation is the amount that must be bid in the auction in order to induce entry. This is the case because the investment cost, expectations of energy and AS revenues over the life of the investment and expectations of future capacity market revenues are all exogenous to the auction. The commitment period plays a critical role in the economic analysis of bidders in that capacity revenues within the period are certain, while capacity revenues outside of the period are uncertain. Additionally, the commitment period is the amount of time during which energy and AS market net revenue expectations will be fixed. Assuming that the auction process continues in the future, clearing prices will reset these energy and AS profit expectations to reflect current market conditions.

Typically contracts between generators and developers have been long-term contracts that have assigned the risk of energy markets to buyers as opposed to sellers. The informative aspect of these contracts is that they have been more expensive as the term is reduced. This indicates that sellers discount post contract opportunities and are wary of post contract risks. The lowest cost contracts are those which enable the seller to fully recover the capital cost over the contract term with no energy market risk. These contracts enable maximum use of debt financing without bankruptcy risk. These contracts, however, achieve low cost by imposing all long-term value risks of the contracted capacity on the buyer.

The CRAM market is a novel and unique market in that energy market opportunities and risks are to remain with the seller and are expected, in a competitive setting, to reduce the offer price for capacity by sellers in the auction From the view of economic principles, any commitment period could meet the basic objectives of the RAM Group. By this we mean that assuring adequacy, providing a meaningful price signal, revealing the appropriate price for adequacy and mitigating market power could all theoretically be accomplished by commitment periods ranging from one year to ten or more years, provided that it is recognized that the price for capacity will be different for various commitment periods.

In approaching the commitment period decision from economic reasoning, we consider more practical factors, such as whether customer alternatives to the capacity market are affected by the choice of commitment period, whether it is more efficient for customers or capacity providers to bear certain risks, and whether other auction considerations would favor any particular commitment period.

The first issue is whether customer alternatives are affected by the choice of commitment period. In this regard, it is the case that if the ISOs make long-term commitments on behalf of customers and will charge LSEs for all capacity market costs, customers will irrevocably bear long-term risks. The use of a long commitment period imposes risks on customers that cannot realistically be avoided. In contrast a shorter commitment period exposes customer mainly to the risk that prices will be high, as even given effective competition, bidders heavily discount post commitment period market opportunities due to the unproven nature of the capacity market and past experience with ISO capacity markets that have cleared at very low levels. Customers could pay a risk premium driven heavily by uncertainty as opposed to realistic fundamentals. However, customers have an alternative to this outcome, which is to enter in to long-term contracts. A key issue is whether this alternative is realistic given current retail markets. Certainly high use customers with sound credit would be able to take advantage of this alternative. For most residential and lower use commercial customers to take advantage of this opportunity, they would have to be willing to enter in to longer term contracts and a practical and enforceable contract would need to be designed or state regulators would have to implement provider of last resort policies that would support long term contracts.

While difficult, these would be possible. If a competitive auction with a three year planning horizon were to clear at a very high price for a one year commitment period as a result of bidders heavily discounting post commitment period revenues, there would still be time for LSEs and customers to arrange for longer term bilateral contracts at lower prices by removing a portion of the post commitment period risk from sellers. Buyers could contract with sellers who had won the auction and arrange for bilaterals in which they could offer sellers a longer-term commitment and in return receive a price lower than the price for the short commitment period.

In sum when we consider the issue of whether customers have alternatives that enable them to manage the risks of alternative commitment periods, we conclude that it would be possible to manage the risks of short term commitment period, but would not be possible to manage the risks of long term commitment periods. This would favor shorter terms. However, there is a potentially significant cost to customers or LSEs entering into longer term bilaterals to avoid high prices of shorter commitment periods and uncertainty with respect to state regulators' ability to act quickly on behalf of customers served by distribution utilities, and as a result practical considerations could favor extending terms somewhat in order to lower price. (Note -- We do not consider this issue from the perspective of sellers as seller participation in the market is voluntary. As such no risks are imposed on sellers that they do not accept and sellers have an opportunity to price all risks that they do accept.)

The next question is whether sellers or buyers could more efficiently bear the risks of alternative commitment periods. Historically, buyers have always bore this risk and done so more efficiently than sellers as a result of exclusive retail service areas and the ability to charge customers all prudently incurred costs, even if out of market. Deregulation has changed this and one of the key premises of deregulation is that investment efficiencies will be achieved if sellers bear the long-term risks of generation investment and buyers only bear the risks that they are explicitly willing to contract for. Again this favors shorter-term commitment periods as opposed to longer-term commitment periods. However, there are some risks that sellers may not be efficient at bearing. Specifically the risks that market will be dropped or modified, the risk that the market will clear at very low prices in times of moderate excesses because generators have no or are unable to exert any pricing power and the risk of regulatory intervention. These risks are greatest at the inception of the market and should diminish as experience is gained with the market and credibility is established. Hence, while this consideration favors a short-term commitment period, it is desirable at the inception of the market to not go too far to a short term to demonstrate to sellers that some of the possible risks are lower than they may imagine.

With respect to the risk of energy market net revenue projections, these projections, which will influence bids, are reset with every auction. If for example, the energy and AS markets net revenues are expected to rise sharply, this would all else equal be reflected in lower offer prices, as bidders would factor greater energy and AS net revenues in to bids. In contrast if markets were to fall, bidders would increase bids to reflect lower energy and AS net revenue expectations. Long-term commitment periods would effectively lock in energy and AS market expectations at the time of the bid and prevent the market from resetting these based on more current information. This lock-in is detrimental to both buyers and sellers and again this favors a shorter commitment period.

The final factor examined concerns considerations stemming from other areas covered in this report. As will be discussed in detail later, NERA has concluded that it would be inadvisable to conduct sequential auctions – that is to purchase parts of the requirement for a commitment period at different times. NERA has also concluded that there is some risk to purchasing the entire amount of capacity for any given year at one time as markets may experience transient conditions that affect price. This latter risk can be avoided without a sequential auction by a staggered procurement with a multi-year commitment period. A staggered procurement can consist for example of buying roughly one third of the need every three years. At any one time all the need is either under contract or being purchased, but the terms are staggered so that they overlap. To the extent that it is consistent with other objectives, this favors a commitment period of greater than one year.

3.3.3. Results of Commitment Period Modeling

The issue that NERA modeled with respect to the commitment period was how alternate commitment periods could affect the price at which resource providers were willing to offer new capacity. The focus of the model was on shorter-term commitment periods as all the factors examined in the section above favored short-term periods. In itself NERA considered the fact that customers would be able to exercise an alternative to potentially negative consequences of short term commitment periods (higher prices) through longer term contracting, but would have no alternative to the potentially negative consequences of long term commitment periods, exposure to long term risks, to be a decisive factor that effectively made long term commitment periods unsuitable for the CRAM.

The modeling done on this issue concentrated on examining the effect of uncertainty with respect to post commitment period price on the fixed cost portion of a generator's incremental cost. As discussed above, a generator's incremental cost of providing capacity can be thought of as the incremental fixed costs less the net energy revenues. Fixed costs were first examined using a 20 year amortization and the real dollar level of fixed charges were determined assuming inflation at roughly 2.5 % and technical progress in generation at about 1.5%. This represents the fixed cost that a generator would consider assuming full confidence that the market in each year would clear at new entrant costs and that there were no long-term risks of greater than anticipated technical progress or fundamental market changes that would render their equipment choice less valuable. This could also be thought of as the price that could be offered if the buyer were to take all long-term market risks and all energy market risks. We then examined the following scenarios:

- Recovery after 10 years would be 25, 50 and 75 percent of the fully amortized costs discussed above, solving for the recovery required during the first ten years to provide a full return on and of invested capital;
- Recovery after the first three years would have a 50% percent probability of being 25, 50 and 75 percent of the fully amortized cost described above, solving for the real annual recovery required during the first three years (and each year in which the discount did not apply) to provide a full return on and of invested capital; and,
- Recovery after the first one year would have a 50% percent probability of being 25, 50 and 75 percent of the fully amortized cost described above, solving for the real annual

recovery required during the first one year (and each year in which the discount did not apply) to provide a full return on and of invested capital.

The results are shown below:

Commitment Period Scenario	**Non-Discounted Combined Cycle Carrying Cost, $/kW-yr ($2004)**
Full Amortization Over 20 Years	$ 94
Scenario 1: 10 years revenues certain	
Remaining years at 25% of fully-amortized cost	$ 123
Remaining years at 50% of fully-amortized cost	$ 114
Remaining years at 75% of fully-amortized cost	$ 104
Scenario 2: 3 years revenues certain	
Rem yrs 50% prob/yr of 25% of fully-amortized cost	$ 134
Rem yrs 50% prob/yr of 50% of fully-amortized cost	$ 121
Rem yrs 50% prob/yr of 75% of fully-amortized cost	$ 107
Scenario 3: 1 year revenues non-discounted	
Rem yrs 50% prob/yr of 25% of fully-amortized cost	$ 156
Rem yrs 50% prob/yr of 50% of fully-amortized cost	$ 134
Rem yrs 50% prob/yr of 75% of fully-amortized cost	$ 115
Note: For simplicity, annual costs are not offset by energy and AS net revenue.	

In viewing these results it is important to remember that these costs are not yet offset for expected energy and AS net revenues. Absent secular trends in those revenues, one would expect that net revenue projections, which are offsets to the cost of providing capacity, would be lower the longer the period as greater uncertainty would prevail.

In interpreting these results, the most significant factor is that expectations as to future capacity market revenue levels are a major driver of price. It is not inconceivable that generators may view the case in which after the initial commitment period, there is a 50% chance that prices in the capacity market will recover only 25% of fixed costs as possible, given the recently depressed levels of capacity market prices in PJM and New York. (Note -- even with the demand curve prices for capacity in New York ROS have been approximately $25 per KW year, which is less than half of the fully amortized fixed cost of a new CT.) While, as we discuss later, there are significant differences between each ISOs existing capacity market and the CRAM model, and current capacity market results should not be considered indicative of the CRAM model, the current markets are likely to influence generator expectations until the CRAM is demonstrated. These results highlight that a critical factor in the success of the CRAM and its ability to achieve its desired objectives at an acceptable price is the degree to which resource providers can be convinced to have confidence in future markets.

The modeling results also indicate and quantify the extent to which commitment period affects potential offer prices for new capacity given various levels of confidence in future markets. To the extent that bidders have full confidence that the CRAM would clear every year at the price of the initial auction, the commitment period would be a moot issue. However, as shown above if resource providers believe that there is a 50% chance that the market would provide in future commitment periods only 25% of the fully amortized capital recovery, the impact on price is measurable. In this case a one year commitment period would cause an increase of about two-thirds in this component of offer price relative to fully amortized costs and a three year commitment period would cause an increase of about 40% relative to fully amortized costs. In contrast the impact would be much smaller with a ten-year commitment period. While the most striking point is that a short term commitment period has the potential to increase prices relative to fully amortized costs (depending on how bidders view future capacity markets), it is also significant that lengthening this period just to three years can provide significant mitigation.

3.3.4. Commitment Period Recommendation

In consideration of the above economic reasoning and model results NERA recommends a three-year commitment period. The rationale underlying this recommendation is as follows:

1. A short commitment period is dictated by the fact that customers have an alternative to the potentially negative consequences of a short period, but have no alternative to the potentially negative consequences of a long period;
2. Three years is sufficiently short that it does not expose customers to long term economic value risks of new investment, but places those risks in the competitive market;
3. A three year commitment period with a three year planning horizon results in energy and AS net revenue expectations only being locked-in for a six year horizon and able to be reset by the market after that;
4. Three years as opposed to one year will moderate prices and could reduce the likelihood that customers will need to exercise an alternative to the commitment period which is desirable as the alternative – contracting on a bilateral basis – has costs and would require regulatory changes to be effective for low use customers;

5. Three years enables a product design that incorporates staggering to avoid having all capacity for a single year at risk for a transient event while not requiring a sequence of auctions.

The three-year commitment period will impose long-term risks on capacity providers. As such it is important to recognize that the prices offered by suppliers of new capacity will reflect these risks and would not be expected to reflect fully amortized costs for investment recovery. We would expect that this will be a more significant issue in the early stages of the CRAM and less of a concern as experience is gained with the market.

The three-year recommendation with respect to planning horizon is based on certain judgments that have been fully disclosed and discussed. This recommendation is not as strong a recommendation as the recommendation for a three-year planning horizon. Without at least a two-year planning horizon, the CRAM will not meet several of the basic objectives and a three-year horizon is needed to efficiently meet these objectives. The same is not true with respect to the commitment period. Basic RAM objectives could be met with a commitment period of one year or two years as opposed to three. The issue is strictly one of trading off risk and price. NERA has formed a judgment that the risks of a three-year commitment are low enough that the potential price benefit is worth the trade-off and the flexibility that the three-year period provides with respect to auction staggering is and additional benefit. Shorter periods meet the objectives, but pose greater price risks to customers. If confidence develops in the CRAM market, it may well be possible to move to a shorter period without any negative impact. Longer commitment periods would also meet CRAM objectives, but would impose on customers a payment requirement that could not be avoided. While it is NERA's judgment that this is not the intent of the RAM proposal and that customers (or regulators on behalf of POLR customers) desiring a long term contract can do so bilaterally, to the extent that customers would universally desire a longer term contract system, this could be done without sacrificing the objectives.

The commitment period is also the topic of our discussion of the 'Percentage Procured' in section 4 of the report. Our discussion in that section concentrates on the auction aspect of how much should be procured in each of the CRAM auctions and how long should the commitment period be. Consistent with our recommendation from our product design analysis, we argue that an overlapping auction structure, in which every year 1/3 of total future ISO demand is procured for a period of three years starting three years after the auction, should be regarded as the best possible solution. However, we also present a workable alternative of an auction schedule of yearly auctions with variable commitment periods, ranging from 1- to 3-years. While such an auction schedule would not be our preferred option, it may be investigated further whether demand response providers would be served by it.

3.4. Consideration of Market Surveys, Feedback from Stakeholders and Consideration of Alternative Views on Planning Horizon and Commitment Period Issues

3.4.1. Summary of Market Surveys and Analysis of Survey Results On Recommendations

In connection with the issues of planning horizon and commitment period two surveys were conducted. One involved generation developers and financiers and was geared to generation investment. The generator survey was geared to a small group to develop ideas as to development and financing constraints and was not intended to solicit generator preferences. The second was geared to demand resource providers. This survey was geared to the specifics of the CRAM proposal and, in particular, aimed to see how alternate planning horizons and commitment periods would affect participation in the CRAM market.

The summary conclusions from the generation survey are as follows:

1. Generators generally felt that a three year horizon would allow sufficient lead time for construction and one generator expressed the opinion that there was sufficient development activity that the horizon need not be so long as to allow for siting and permitting;
2. Generators were split on the issue of the acceptability of the ISO as a counter party with credit support flowing from a tariff authorizing charges to LSEs, with roughly half finding this acceptable and the other half finding it unacceptable as a result of the ISOs′ asset position;
3. Generators and financiers were generally skeptical of the stability of the CRAM and the degree to which uncontracted revenues could be relied on to support debt; and,
4. Financiers generally believed that commitment periods of ten years would be required to support debt financing.

The results of the survey were considered, but do not give rise to any changes in the recommendations of commitment period and planning horizon. This is the case because of the following:

1. The survey was consistent with the planning horizon recommendation;
2. The survey result indicating skepticism of the ISOs′ creditworthiness is not universal and should be able to be alleviated by education and regulatory assurances;
3. The survey result recognizing that there will be skepticism of the CRAM and the corollary result that in order to obtain debt financing a ten year commitment period is

the minimum had already been recognized and is a hurdle in making the market workable – however, the only suggested remedy is to significantly increase the commitment period to ten years and as discussed above this imposes long term risks on customers involuntarily which is inconsistent with direction the states have taken with respect to deregulation of generation; and,

4. We believe that given competitive conditions and the prospect of bidding in the CRAM and winning or having a competitor obtain a capacity contract, generators are apt to be more aggressive than indicated and it would be inadvisable to either abandon the CRAM or select a ten year commitment period without testing the market to see what price is required in order to induce entry with the shorter commitment period.

The generator and financier survey does indicate that the initial implementation of the CRAM will be difficult and that significant effort will need to be dedicated to educating participants as to the stability of the market, to providing clear guidance as to how the market may be monitored and mitigated, to addressing concerns over volatility in current ISO capacity markets and to enlisting regulatory support at the state and federal level for the market. Moreover, there must be a clear expectation that in attempting to assure development without a longer-term contract, there will be a transition period in which prices may be higher than expected. The CRAM has the longer-term promise to work with shorter commitment periods, not because those periods are sufficient to support financing, but because the market structure should establish confidence among generators of two important facts. The first is that the market will provide an ongoing opportunity for revenue needed to provide reasonable returns that will sufficiently reliable to be counted on in making investment decisions. The second is that the market will encourage development of an amount of capacity that meets but that does not far exceed reliability requirements. This will give bidders greater confidence not only in future CRAM revenue but also in energy and AS net revenues as depressed prices from surplus supply condition should be less likely.

The results of the demand survey are easily summarized. The vast majority of demand resource providers have clearly stated that they will either not participate in the CRAM auction or will significantly reduce their participation if they are required to make commitments several years ahead of the delivery date. From a demand resource perspective any combination other than a planning horizon of one year and a commitment period of one year, which would limit the forward commitment to a total of two and one half years from the date of the auction will, according to survey results, significantly reduce auction participation Note that we assume that the auction would be conducted between November and February. As the commitment period starts on June 1, this adds a half -year to the nominal commitment period.

The rationale behind these responses appears to be that longer total planning horizon and commitment period combinations are simply incompatible with the business model and underlying economics of many demand side resources. (Note: There are exceptions to this and in particular demand resources that require significant investment may in fact benefit from a longer commitment period, but these exceptions do not change the fact that a vast majority of responding demand resource providers indicate that they will be unable to participate at the recommended planning horizon and commitment period and that anything other than reducing both the planning horizon and commitment period to one year each would not appreciably change this. Further this constraint is not one of preference, but flows from the basic economics of many of the demand resources, that customers are unwilling to commit to demand reductions several years in advance as they are uncertain whether such reductions will be economical.

The demand resource situation creates a dilemma. In order to assure adequacy, provide meaningful price signals from generation resource bidders and mitigate market power, a three-year planning horizon is essential. Absent consideration of the commitment period, this in itself will limit demand resource participation. It is an objective of the RAM to not discriminate against resource types and it is highly desirable to encourage demand resource participation. However, shortening the planning horizon would undermine the ability of the CRAM to meet objectives as new generation resources will continue to be required and are available in much larger quantities than demand resources.

The demand resource provider survey does not lead to a change in the recommendations for the planning horizon and commitment period. However, it does give rise to a recommendation that demand resources that are unable to effectively compete in the auction be provided other opportunities. These opportunities could potentially lead to auctions reserved for demand resources with a shorter planning horizon, continuation of administered demand resource programs or other alternatives. These alternatives will be discussed briefly in Section 10 of the report.

3.4.2. Feedback from Stakeholders

Stakeholder meetings have also provided feedback on the issue of planning horizon and commitment period. The most notable points and our comments on these points are presented below:

- A three year planning horizon will raise prices as it is more likely that with the three year horizon there will be a need for new capacity and the auction will close based on the price requirements of a new entrant.

  Comment- If new capacity is required, the capacity price must rise to the level required to attract entry. Competition should assure that prices rise no further than required and that opportunities for net revenue in energy and AS markets are reflected in the offers. The view that

the planning horizon will, by its long-term nature, cause prices to reflect the net cost of entry is correct. What is wrong is to extrapolate this view to a view that sufficient entry could be achieved without letting the price rise to reflect the net cost of entry. There is a logical flaw in that extrapolation. It assumes that new units will be developed on a continuous basis even though the price is chronically below the amount of revenue required (in consideration of revenues from other markets) to provide for recovery of investment costs and hence is illogical.

- A three-year commitment period is inadequate to support financing for new units and will lead to extremely high prices or lack of interest due to an inability to finance new generation.

  Comment – As discussed above, generators and financiers have strongly expressed that a longer-term contract will be required to obtain debt financing while offering reasonable prices. The issue is entirely dependent on the degree of confidence that can be established in the CRAM and the regulatory and institutional certainty that can be provided. To the extent that these financeability and price concerns are accurate, and we have no reason to believe to the contrary, they would apply even more strongly to rule out shorter planning horizons, which would require financing before any contract was obtained and to rule out commitment periods shorter than three years, other than as an option for a portion of the requirement. Hence this feedback, while raising a serious issue is supportive of the direction of the recommendations. To the extent that the prices resulting from a three-year commitment period would be unacceptably high, customers acting through LSEs or POLRs acting under state direction could enter longer-term bilateral contracts with auction winners for longer terms and lower prices. While the CRAM concept could possibly be extended to include ten-year commitment periods, such a long commitment period raises other possible issues and we have not investigated the complications that could arise from such a long commitment period.

- Capacity qualification requirements for units not already under construction are too speculative and such units cannot assure adequacy.

  Comment – While capacity qualification requirements are an important issue and there will always be some risk to whether capacity in development will actually be built, this concern highlights the need to carefully review qualification criteria. If capacity that wins in the auction, meets qualification criteria and posts financial security can not be developed in order to met adequacy needs, the development certainty of capacity that would be available in a shorter lead time auction, say one year, is far less certain as such capacity would have no contract and would not have posted any financial security. Taken to the extreme, this concern says that it is impossible to use a capacity market to assure adequacy and that it is in fact impossible to assure adequacy, as it will not be possible to assure adequacy without relying on units that are not already under construction

- Credit requirements for a three-year planning horizon and commitment period may be too high to result in a workable market.

  Comment – The ISOs are expected to address credit requirements from sellers. There will be a balancing needed between credit requirements that will protect the ISOs and customers and the cost that those requirements impose on offer prices. NERA has not reviewed the ISOs′ credit proposal as it is still under development. CRAM will need to consider this in formulating a recommendation on deficiency charges.

- Generation owners may be unwilling to commit to a three year commitment period because of concerns that the unit may be uneconomic to operate for the full three years or may be faced with requirements that it retrofit or shut down prior to the three full years.

  Comment -- This is a valid concern. While we believe that there are benefits to a three-year commitment period, there may well be a reason to provide a choice of commitment periods. Some resource provides that have units in their portfolio that can economically operate for one year or two years may benefit from multiple contract lengths being offered on a regular basis. The same would be true of demand resources, although it is not clear that it would have much effect on those resources as the three year planning horizon is in itself a significant problem for these resources. The rolling auction with a variable commitment period could then be implemented. Moreover, there is an opportunity to participate in reconfiguration auctions that have shorter commitment periods. The exact proportion of the contract that would be provided on a one-year, two-year or three-year basis would be part of the final business rules and are outside the scope of NERA′s assignment.

- A mix of one and three year commitment periods may help solve the issue of demand resource participation.

  Comment -- This is potentially solvable in two ways. The first would be the sole use of a one-year commitment period, which is an overly blunt solution. The second would be to provide for the possibility of various commitment periods through a rolling auction format with variable commitment periods. As noted above the exact details may be complicated and specification of business rules is outside the scope of NERA′s assignment. However, it should also be noted that the demand for shorter commitment periods may be met in reconfiguration auctions.

- The Auction would essentially purchase an amount of capacity equal to the capacity bought from plants completing the prior three-year commitment period, plus one year of load growth adjusted for reserve. Especially in locational markets where load could be as low as, say 5000 MW and load growth as low as 50 MW per year, this would pose difficulties for entry by larger, less costly units and drive up costs.

Comment -- Even absent this small market concern, NERA has anticipated that detailed auction rules would need to be developed that would not exactly specify a capacity requirement, but would incorporate some form of band to allow for a full unit to receive capacity payments even if only part was needed. The small market concern raises questions as to whether as to such rules could be reasonably developed for small markets. Smaller markets are inherently subject to periods of excess supply, if the capacity requirement is an absolute minimum, unless smaller units are added to match load growth. In practice, the industry, when vertically integrated, has rarely added small units year after year for local reliability needs, and this would indicate that this solution is not the least cost. There is no clear way to use a simple market mechanism such as the CRAM to capture and evaluate the trade-offs between adding larger units and experiencing a period of surplus and adding more expensive units that may better match load growth. To the extent that the ISOs are divided in to several smaller regional markets a market model more complicated than the CRAM model may be required. Alternatively, the capacity target in a regional market could be set higher than required in order to allow for the ISO to purchase more capacity than required and the commitment period could be extended to hold off the subsequent auction until load growth would justify the need for additional capacity. This would avoid a situation where a market chronically was exposed to high prices as new entrants were always smaller scale units and also avoid the situation where a single entrant would be exposed to large risks that after the initial commitment period locational prices would be low due to a capacity surplus caused by the addition of a single unit. This leads to a recommendation that commitment periods be reviewed for smaller markets and the need for longer commitment periods in such markets be considered. This recommendation is consistent with economic principles. Smaller markets tend to be more expensive generation locations (e.g., New York City, Long Island, Boston) and investment in generation in those areas is a classic case of a specialized asset. While the capacity could be used to supply capacity in non-local markets (e.g., New York City capacity used in the rest of the state) the value is not commensurate with the cost. Specialized assets are subject to exploitation after having made the investment and require longer-term contractual assurances. NERA recommends that further analyses be conducted as to how to modify the CRAM to accommodate smaller markets.

3.4.3. Consideration of Alternative Views

While NERA's scope does not include a comparison of the CRAM market to other alternatives, we briefly comment on one alternate view that is directly relevant to the issue of planning horizon and commitment period. That view is that the market model can encourage adequacy by providing an additional source of revenue to generators and demand resource providers, will hence encourage entry and as a result lead to resource adequacy. Such a market could conceivably utilize a shorter planning horizon as the objective is not to use the market to develop contractual assurances of adequate capacity, but rather to provide added revenues to compensate for the fact the energy and AS markets do not provide sufficient revenues to assure adequate supply. We agree that the energy and AS markets at the current time would not encourage entry on their own. We have not been asked to evaluate whether such an alternative market would be equally, less or more effective than the CRAM at assuring adequacy. What we do believe is that a shorter planning horizon would be as problematic in such a market as in the proposed CRAM and would lead to prices clearing either at a cap or at very low levels. Hence, we believe that even given the view that the market model should be designed to provide supplemental revenue to encourage entry as opposed to obtaining contractual assurances of entry, the same recommendations would apply as to planning horizon and the same concerns would exist as to the need to establish investor confidence in the market in order for developers to be able to offer reasonable prices and obtain debt financing.

4. PERCENTAGE OF OBLIGATION PROCURED

The proposal envisages that all of the ISO′s unforced capacity obligation will be procured through a centralized process. The proposal could be implemented either by having the full obligation procured through a single auction, or by having multiple auctions each used to procure a percentage of the obligation.

The question examined in this section is whether the obligation for a given commitment period should be procured:

- In a single auction, in which case the price paid by the LSEs during the commitment period would be the auction price;
- Through multiple auctions, each auction being used to procure a percentage of the obligation for a set commitment period, in which case the price paid by the LSEs during the commitment period would be a weighted average of the auction prices;
- By some other method that would involve multiple auctions.

The RAM Group has considered the first two options. We understand that the RAM Group had considered alternatives to a single auction in recognition of the fact that a single auction exposes the ISO to the risk that some uncontrollable market event or some unusual event outside of the scope of the market that could influence the competition at the auction and the resulting price. Since the resulting price is then paid by LSEs for the entire term of the obligation, this exposes the ISOs and all consumers to paying prices that are the product of unique conditions rather than being reflective of the underlying fundamentals of the market.

The RAM Group asks whether using a single auction or using multiple auctions to procure the requirement for a set commitment period can accomplish the stated objectives, or whether another solution may be more appropriate.

The overreaching objectives are for the procurement process to provide meaningful economic signals and to ensure resource adequacy. Our analysis has been guided by the following key questions for each option:

- What is the effect on bidding behavior?
- Does the option facilitate entry and the participation decision, and if so how?
- Is the option more or less vulnerable to the gaming and to the exercise of market power?

- Is the option more or less vulnerable to the effect of transient market conditions or events?

This section is organized as follows. We start by summarizing results in the auction literature that directly speak to the use of multiple auctions to procure the obligation for a set commitment period. We next categorize the options available to the ISOs. Finally, we provide candidate options that could meet the desired objectives, and provide an assessment according to the key questions above.

4.1. Relevant Results From the Auction Literature

Over the past twenty years, the auction literature has directly considered the question of whether procurement done through a single auction is more likely to achieve better prices or a more efficient result than procurement through multiple auctions. The auction literature has not reached a definitive answer. Debates continue and models are still being developed. These models aim to capture the differences in the strategic behavior of bidders between the case of a single auction on the one hand and the case of a multiple auctions on the other, and in so doing contribute to the debate as to whether there is an advantage to a procurement through multiple auctions.

The interest of auction specialists in this question comes from a basic tension between theory and fact. Simple theoretical intuition would say that whether procurement is done through a single auction, or through multiple auctions held one after the other in a sequence, should not matter to price or to the efficiency of the result. Surely, the intuition would go, in a sequence of auctions, no bidder would sell in an earlier auction unless the bidder was convinced that prices were going to be about the same or a somewhat worse in later auctions. Similarly, a bidder who waits must believe that there is no loss to doing so because the price in later auction must be about the same or better than in earlier auctions. The only way all bidders – those who choose to bid in earlier auctions and those who choose to bid in later auctions – can be right, and the only way that there can be a equilibrium – in the sense that no one regrets their decisions after the fact – is if the prices are on average the same across all auctions.

An early theoretical model by Weber (1983) formalized this intuition. The results of this model would imply that, although prices may not be identical from one auction to the next when multiple auctions are used for a set commitment period, prices would nevertheless be the same on average. Further, whether a single auction was used or multiple auctions were used to procure the obligation for a set commitment period, the same bidders become winners and there is no implication for the efficiency of the allocation. A single auction and multiple auctions would then yield the same results on average, but since multiple auctions protects from the risk of the payment for LSEs being exposed to transient market events, multiple auctions would seem to be a preferable solution.

The seminal paper by Ashenfelter in 1989 was the first paper to present convincing data that refuted the theory just discussed. Subsequently, reports of data from auctions conducted in all parts of the world and for a variety of products and commodities (wine, art, condominiums, fur pelts, etc.)[4] also appeared to contradict simple intuition that using a single or using multiple auctions should not influence price. Indeed, it was instead observed that when identical items were auctioned one after the other in multiple auctions, prices were not the same across auctions. Indeed, prices could vary very significantly. Even more problematic, prices were not on average the same when comparing the price of items in a single auction with prices for the same items when multiple auctions were used. In the case of multiple auctions for procurement, most often prices would be lower in earlier purchases and gradually rise later on. The empirical evidence was convincing, and led to the rejection of the intuitively appealing view that conducting a procurement through one auction or through multiple auctions should make no difference to price or to the efficiency of the allocation.

Ashenfelter termed these results "price anomalies" and he pointed out that auction specialists faced a challenge. This challenge was to analyze in more detail the strategic behavior of bidders in multiple auctions in a way that could explain the empirical pattern of prices. An important body of work ensued, each study in the following years contributing to our understanding of bidding and strategies in a multiple, sequential auctions context. Although none of these studies became the final word on the subject, what each study shows in its own way is that having many auctions of the same product makes bidding strategically very complicated for bidders.

Suppose, for example, that 25% of the capacity requirement for 2007-2010 is auctioned 2004, 50% of this same requirement will be auctioned in 2005 and 25% in 2006 (see Figure 4-1).

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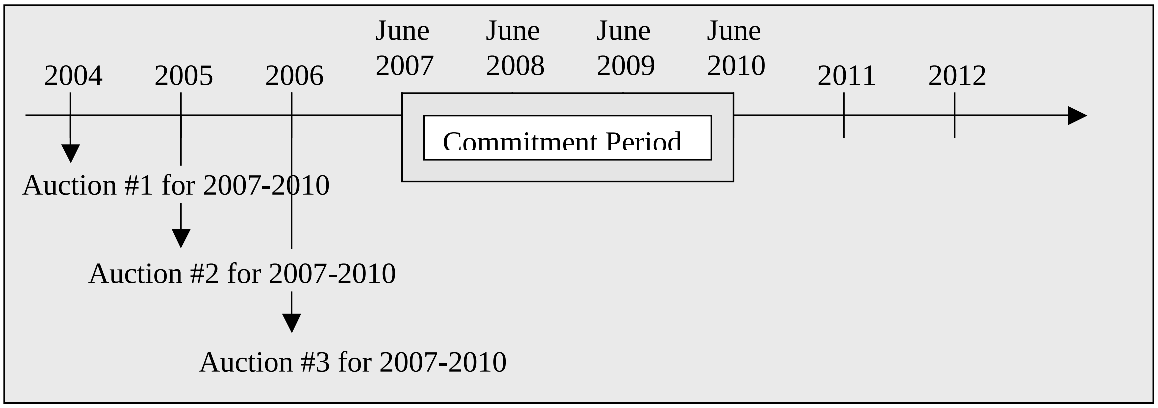
[4] See among others, Ashenfelter (1989), Vandeporten (1992), Ashenfelter and Graddy (2002), and Thurston (2002).

Figure 4-1
Multiple Auctions for a Set Commitment Period.



When faced with multiple auctions, each affording the same economic opportunity, a bidder must decide not only how to bid in a given auction, but a bidder must decide in which auction(s) to bid as well. A bidder will need to consider two opposing effects. On the one hand, in later auctions, other bidders may have already sold all, or some, of the capacity that they intended to sell; a bidder selling in later auctions can then face less competition and potentially be able to obtain a better price. On the other hand, in later auctions, there may be fewer or no future opportunity to sell capacity; a bidder selling in later auctions will then face more aggressive bidding and potentially get a worse price.

Whether a bidder decides to bid in early auctions or in late auctions will depend on how the bidder evaluates the relative strengths of these opposing effects. As recent models in the literature show, the bidder's decision of when to bid will also depend on a variety of other factors, including:

- How averse to risk a bidder is – if a bidder is sensitive to risk in particular ways, a bidder will be willing to bid lower in earlier auctions rather than risk an uncertain future price (see McAfee and Vincent, 1993);
- Whether bidders are well informed about each other's plans to provide capacity to the market or about each other's opportunity cost of providing new or existing capacity – a bidder may worry that it is providing information to the market by participating in early auctions and may hold off participation, or it may bid to mask any information it would be giving to the market;
- Whether a bidder places a higher value on having the whole of its plant committed rather than having only a portion of its available capacity committed through the

auction – a bidder may then be willing to bid lower in earlier auctions (see Menendez and Monteiro, 1999);

- Whether a bidder will acquire information between auctions – if a bidder believes that new information will become available that is relevant to evaluating the economic opportunity afforded by the auction, the bidder can choose to pass on earlier auctions, in particular if the amount of the requirement is uncertain (See Feng and Chatterjee, 2002) .

Any of these factors can make a bidder faced with multiple auctions for the same product uncertain about ***how to bid*** and ***when to bid*** (i.e., in which auction). These complexities and the ensuing uncertainty for bidders have a very concrete implication. Bidding behavior in multiple auctions for the same commitment period will likely be unpredictable. The price signals from the auctions will reflect the complexity of the bidding task and as such cannot be expected to relate consistently to the underlying economic realities of the market.

Such unpredictability has several consequences. First, such unpredictability would defeat one of the primary objectives of the auction process, which is for the auctions to provide a reliable price signal for resource adequacy. Second, given that the price signal cannot be expected to be reliable and given that rational behavior may lead to complex bidding strategies to take into account the multiple auction environment, it will be complex to develop clear criteria for monitoring this bidding behavior or for deciding when the auction result should be mitigated. Finally, given that bidders will factor future price expectations into current bids, an unpredictable price pattern may undermine the bidders′ confidence in the centralized auction market and may result in higher bids. We believe that this conclusion should in and of itself remove from consideration the use of multiple auctions for a set commitment period.

Conclusion and Recommendation

Holding multiple auctions for a set commitment period raises strategic complexity and raises uncertainty for bidders. The price signal from multiple auctions for a given commitment period is less predictable, less related to the underlying economic fundamentals of the market, and therefore more difficult to monitor and mitigate with a clear set of rules.

We find that using multiple auctions for a set commitment period is not acceptable as it is unlikely to satisfy the goals of the ISOs.

It is important for us to emphasize that the conclusion just drawn is very specifically for situations in which resource providers have a choice of auctions, and that resource providers can pass up on the first auction but have the same economic opportunity in a future auction. Resource providers, if they do not bid in the first auction, are not absolutely foregoing an economic opportunity. The conclusion applies, in the simplest instance, to the situation illustrated in Figure 4-3, where there are two auctions used to procure the requirement for the same commitment period from 2007 to 2010, so that both auctions present the same economic opportunity.

4.2. Procurement Options

Having eliminated from the list of acceptable options the use of multiple auctions for a set commitment period, it may appear that the only remaining option is to have a single auction to procure 100% of the requirement, and to accept the risk of transient events. Fortunately, that is not the case. Multiple auctions for a set commitment period are at one extreme, a single auction is at another extreme, but there are many configurations in between that involve multiple auctions. These configurations involve multiple auctions for different – and sometimes overlapping – commitment periods.

We provide a roadmap to these configurations in the next section and we explain how they avoid the extreme problems of multiple auctions all for a set commitment period. In examining these alternative configurations, we will also ask whether these configurations:

- Avoid the bidding complexities and the unpredictability of price that we associated with multiple auctions for auctions for a set commitment period;
- Provide reliable price signals that are representative of market fundamentals;
- Have advantages over single auctions in terms of minimizing the exercise of market power;
- Have other advantages over single auctions in terms of encouraging participation in the auctions;
- Are simple for bidders to understand and simple for the ISOs to administer.

We will begin by presenting again the two "extreme" cases consisting of a single auction and a multiple auctions for a set commitment period, and we will continue by introducing other possible configurations. In examining these alternative configurations, we will assume a three-year planning horizon and a three-year commitment period, in keeping with the recommendations earlier in this report (see Section 3). Next, we will examine how these configurations could be adapted to other acceptable commitment periods or other possible planning horizons. We will finish this section by considering configurations proposed to us by some stakeholders.

Option 1: Single Auction For a Set Procurement Period

If a single auction were used for each three-year commitment period, auctions would occur every three years, as represented below:

Figure 4-2
Single Auction For a Set Commitment Period.

	Capacity for requirement in years (June 1 to May 31)			
Auction held	***2007 – 2010***	***2010 – 2013***	***2013 – 2016***	***2016 – 2019***
2004	100%			
2007		100%		
2010			100%	
2013				100%

A single auction is the simplest option. The frequency of the auction (i.e., how often auctions are held) will be determined by the commitment period. With a three-year commitment period, an auction will be required every three years; if an ISO were to choose a one-year commitment period, an auction would be held every year.

The predictability and simplicity of this configuration is an advantage to the ISO and the bidders alike. The administration of the central market is uncomplicated for the ISO. The bidding is uncomplicated for the bidders – that is, although bidding undoubtedly requires a complex evaluation and strategy, this strategy is not further complicated by a multiple auction configuration. Such simplicity for the bidders means that the price in the auction will be a reliable reflection of market fundamentals. This price will be a result of the competition among bidders and their evaluation of committing their resources as a function of the market fundamentals.

This simplicity comes at a cost. Although the price signal should be a reliable reflection of market fundamentals, market participants will get this signal infrequently. With multiple auctions, as long as these auctions are staggered through time, market participants can observe an array of prices instead of a single price. Further, all resource providers commit their resources for the entire commitment period. To the extent that some resource providers (e.g., demand response providers) do not share the preferences of the majority regarding the most appropriate commitment period, this configuration may not elicit their full participation.

As noted in the introduction, the reliability of the price signal from a single auction may be compromised by the advent of an uncontrollable market event or some unusual event outside of the scope of the market. The best estimate of the future value of capacity could be intimately related to the current price of energy and volatile or transient current energy spot price may be one of the drivers of capacity prices. This event could be the advent of war, the need for the repair of a facility leading to uncertainty as to whether the facility will continue to operate, or an important yet transitory increase in the price of natural gas. Resource providers would take these events into account when bidding in the auction, especially if there is uncertainty as to whether they are transient or not. Holding the auction earlier or later would have resulted in a different price, which may have reflected the same market fundamentals without also reflecting events that were in fact transient. There is always a risk of a transient market event affecting auction results; but with a single auction for the entire commitment period, the influence is felt over the entire commitment period instead of being more limited. LSEs would pay the resulting price, even though it did not only reflect market fundamentals, for the full term.

Option 2: Multiple Auctions for a Set Commitment Period

The situation illustrated below assumes a planning horizon of at least two years and assumes that the length of the commitment period is three years. It also assumes that the ISO procures the requirement for a given commitment period in two auctions, each for 50% of the requirement.

Figure 4-3
Multiple Auctions for a Set Commitment Period.

	Capacity for requirement in years (June 1 to May 31)			
Auction held in year	***2007 —2010***	***2010 —2013***	***2013 – 2016***	***2016 – 2019***
2004	50%			
2005	50%			
2007		50%		
2008		50%		
2010			50%	
2011			50%	
2013				50%
2014				50%

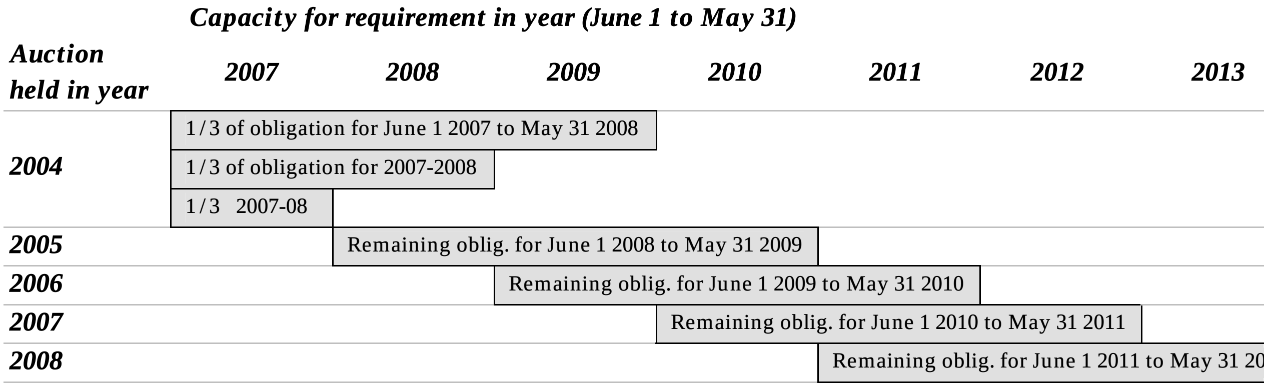
With this configuration, the planning horizon – the length of time between the auction and when bidders must first provide their resources – cannot always be the same. If a first auction is held three years and three months before the start of the commitment, and a second auction is held at a later date for the same commitment period, then the lead-time of the second auction must be shorter. The planning horizon is three years and three months for the first auction, but it is shorter for the second auction.[5] Multiple auctions of this sort would have to be scheduled with care to benefit fully from the planning horizon set by the ISOs.

This configuration of multiple auctions is the configuration that is directly analyzed by the auction literature and reviewed in the previous section. In this configuration, bidders face a choice of what to bid, but also when to bid. Both auctions offer exactly the same economic opportunity. All the problems raised in the previous section would apply. The complexity of the bidding decisions means that price signals cannot be expected to be meaningful and to reflect the economic fundamentals of the market. The price signals are more frequent than in the previous environment but are less likely to be easy to interpret and to guide economic decisions. As mentioned in the previous section, we believe that this option is not acceptable as it cannot fulfill the goals set by the RAM Group.

<u>Option 3: Rolling Auction With A Single Commitment Length</u>

The configuration is represented in the figure below.

Figure 4-4
Rolling Auction with a Single Commitment Length.



There is a transition auction in 2004, which we discuss later in this section. Starting in 2005, the auction proceeds in the same way every year. Every year, providers bid to commit resources for three years with a three-year lead-time. For example, for the auction held in 2005, a rectangle from 2008 to 2011 is shaded, representing the fact that providers bid to commit resources from June 1 2008 (a three-year lead-time) to May 31 2011 (a three-year commitment). The obligation in any given <u>year</u> is provided through multiple auctions, and each auction offers contracts of differing, but overlapping periods of commitment. For example, the obligation for 2010 is

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[5] It is assumed in this example that the auction is conducted in March.

provided through an auction in 2005 (where June 1 2010 to May 31 2011 is the last year of the commitment for which providers bid in 2005), through an auction in 2006 (where June 1 2010 to May 31 2011 is the second year of the commitment), and finally through an auction in 2007 (where June 1 2010 to May 31 2011 is the first year of the commitment).

We call this configuration a "rolling auction with a single commitment length". There is a single commitment length of three years; providers always bid to obtain a contract for a period of three years. (There is a fixed planning period as well: providers always bid for a contract three years into the future.) As new auctions are held from one year to the next, the beginning of the commitment period shifts or "rolls" by one year as well. For example, in 2005, resource providers commit from June 1 2008 to May 31 2011; in 2006 – one year later – they commit from June 1 2009 -- one year later – to May 31 2012, etc.

From the point of view of bidders, the market organization is straightforward. The planning horizon is fixed at three years, and save for the transition auction in 2004, the commitment period is fixed at three years. Each year, an auction is held for the same type of product, namely a contract that commits their resources for three years beginning in three years' time. A bidder that commits its entire resources in an auction conducted in a given year, say in 2006 (for resources in 2009-2012), would not be available to participate in another auction with the same resources until 2009 when an auction is conducted for resources in 2012-2015. This would result because those resources will be under contract for the period between 2009 and 2012. For all the years in between, the bidder would be able to commit additional resources, should they construct or acquire additional resources. In the transition auction of 2004, all contracts start in 2007 (the planning horizon is fixed) but not all contracts have the same length (the commitment period is variable). Contracts of one, two and three years are offered. This transition is necessary to ensure that the obligations for 2007, 2008 and 2009 are met, and that the market can come as quickly as possible to a stable situation in which each year a similar auction is held.

The ISO determines the obligation on a yearly basis. The amount procured in a given auction is the portion of the obligation for the first year of the commitment period that has not yet been procured through previous auctions. An example is provided in Figure 4.5. In 2007, the first year of the commitment period is June 1 2010 to May 31 2011. The ISO determines the obligation to be 33,725 MW. Of this obligation, 22,300 MW were procured through auctions in 2006 and 2007 (11,100 MW plus 11,200 MW). Thus, 11,425 MW is procured in the 2007 auction. Since it is procured for a three-year period, 11,425 MW is also being procured for June 1 2011 to May 31 2012 and June 1 2012 to May 31 2013. Therefore, when determining the amount to be procured in the 2008 auction, the ISO would consider:

- 11,200 MW procured in 2006 for the year June 1, 2011 to May 31, 2012;

- 11,425 MW procured in 2007 for the year June 1, 2011 to May 31, 2012 (for a total of 22,625 MW);
- the obligation for the year June 1, 2011 to May 31, 2012, which is 34,003 MW.

The auction in 2008 is the third and last auction for which resource providers will be committing resources for the year June 1, 2011 to May 31, 2012, and the amount to be procured is set so as to meet the requirement for that year. The amount to be procured would then be 11,378 MW = 34,003 MW – 22,635 MW.

Figure 4-5
Example of Amounts to be Procured.

Year and Obligation for year	Auction	Commitment Period	Amount Procured
June 1 2010 to May 31, 2011 33,725 MW	Auction 2005	June 1 2008 to May 31, 2011	11,100 MW
	Auction 2006	June 1 2009 to May 31, 2012	11,200 MW
	Auction 2007	June 1 2010 to May 31, 2013	11,425 MW
June 1 2011 to May 31, 2012 34,003 MW	Auction 2006	June 1 2009 to May 31, 2012	11,200 MW
	Auction 2007	June 1 2010 to May 31, 2013	11,425 MW
	Auction 2008	June 1 2011 to May 31, 2014	11,378 MW

This configuration has the advantage of shielding capacity prices for a given year from market events that are potentially transient. The obligation in a given year is met through three separate auctions held in three separate years (in Figure 4-5, each column, which represents a the obligation for a given year, has three shaded blocks, each representing the amount procured in one auction, and each shaded block is for a different auction year). Compared to auctions for the entire requirement, this configuration provides market participants with more frequent price signals. This configuration provides for a yearly price signal while an auction for the entire requirement provides a single price signal every three years.

Compared to multiple auctions for a set commitment period, the price in this configuration will be more reliable. Each auction provides bidders with a different economic opportunity. Bidders do not have a choice of when to bid: if a bidder chooses not to participate in a given auction, the bidder has forever foregone the opportunity to provide resource for a one-year period three years into the future – no future centralized auction will procure resources for that period again. For example, if a resource provider committed its resources on a three-year basis in the 2004 auction, but if the resource provider fails to participate in the 2007 auction, the resource provider will not be committing its resources for the year June 1, 2010 to May 31, 2011. The bidding task does not involve deciding which auction to participate in. The bidding task is not as complex for bidders and does not suffer from the problems analyzed by the auction literature.

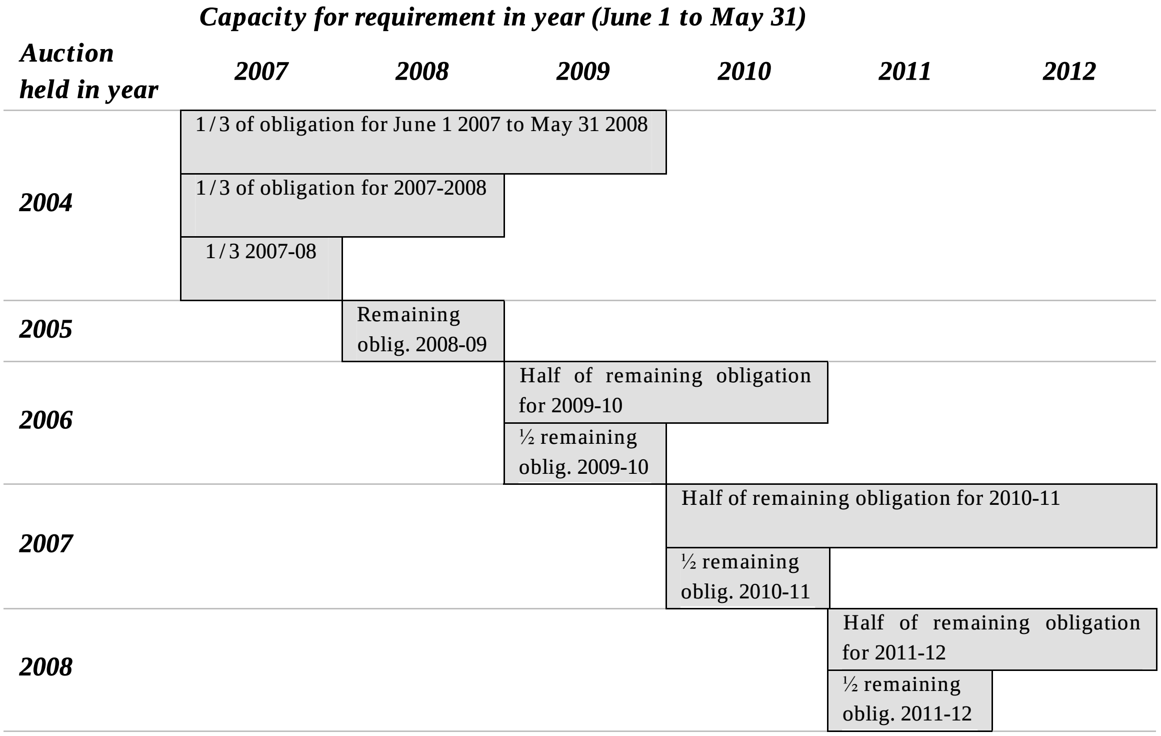
The transition auction does not suffer from the problems analyzed in the auction literature either as it is assumed that all contract lengths (one, two and three years) are procured simultaneously in a single auction. The descending clock auction format accommodates such simultaneous procurement. Providers come to a single auction and can decide on the prices that they see as the rounds progress which contract length they would rather bid on.

The environment is simple to manage for bidders, and simple to administer for the ISO. A single auction is held each year, and the obligation to be procured is the amount not yet under contract for the first year of the commitment period. One disadvantage of this configuration is that all resource providers must be willing to commit resources for a three-year period. To the extent that not all resource providers have the same preferences concerning the commitment period, or to the extent that a segment of resource providers, such as demand response resource providers, are unable to participate if the commitment period is long, then this configuration may not maximize the participation in the market.

Option 4: Rolling Auction for Variable Commitment Length

The configuration is represented in the figure below.

Figure 4-6
Rolling Auction with a Variable Commitment Length; Products Auctioned by Year.



Starting in 2004, there is one auction every year, often for more than one contract length. The contracts offered at auction always begin in three years′ time; that is, the planning horizon is constant at three years. However, the contract lengths, or commitment periods, are variable. For example, in 2006, both one-year and two-year contract lengths are offered at the auction, and both types of contract are for an obligation that begins in 2009. In any year in where several contract lengths are offered, these contract lengths would be auctioned simultaneously. This allows providers to choose, on the basis of the relative prices revealed through the auction, which products they want to provide.

We call this configuration a "rolling auction with a variable commitment length." There are three possible commitment lengths, one year, two years and three years. (There is a fixed planning period, however: providers always bid for a contract three years into the future.) As new auctions are held from one year to the next, the beginning of the commitment period shifts or "rolls" by one year as well. For example, in 2005, resource providers commit from June 1 2008 to May 31 2011; in 2006 – one year later – they commit from June 1 2009 — one year later – to May 31 2012, etc.

The mechanics of which contract length is offered in a given auction is as follows:

- Every year, the auction offers contracts with a length of one year;
- Every second year, the auction offers contracts with a length of two years;
- Every third year, the auction offers contracts with a length of three years.

This is illustrated in Figure 4-7 below. This figure provides the same information as Figure 4-6 above, except that the figure is organized by product type instead of by auction year.

Figure 4-7
Rolling Auction with a Variable Commitment Length; Auction by Product Type.

	One-Year Products					
Auction held in year	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***
2004	1/3 of oblig. 2007-08					
2005		Remaining oblig. 2008-09				
2006			½ remaining oblig. 2009-10			
2007				½ remaining oblig. 2009-10		
2008					½ remaining oblig. 2010-11	
	Two-Year Products					
2004	One-third of obligation for 2007-2008					
2005	No two-year product offered					
2006			Half of remaining obligation for 2009-10			
2007	No two-year product offered					
2008					Half of remaining obligation for 2011-12	
	Three-Year Products					
2004	One-third of obligation for June 1 2007 to May 31 2008					
2005	No three-year product offered					
2006	No three-year product offered					
2007				Half of remaining obligation for June 1, 2010 to May 31 2011		
2008	No three-year product offered					

Most years, one or two contract lengths are offered. Every six years, all three contract lengths will be offered in the same auction. This occurs in 2004 and, if we were to continue Figure 4-7 through time, it would occur again in 2010.

This configuration aims to keep many of the advantages of the rolling auction with a single commitment length while allowing more flexibility to resource providers by offering variable commitment lengths. A range of commitment periods allows resource providers that prefer certain contract lengths, or that must match contract lengths to their particular business plans, to do so. A range of commitment periods thus is more apt to maximize participation in the auction and to allow resource providers to submit the most competitive bids for the commitment length that is most suited to them. However, this flexibility, and the advantages that it procures, must be traded off against a loss in some of the advantages that a rolling auction with a single commitment length can deliver.

The rolling auction with a single commitment length meets the obligation in a given year through auctions held in three different years. In any one auction, no more than roughly one-third of the obligation for a given year is procured, which shields capacity prices for that year from market events that are potentially transient. Figure 4.6 provides an example of a rolling auction with a variable commitment. The rolling auction with a variable commitment length does provide some protection against potentially transient market events, but does not provide as much protection as a rolling auction with a single commitment length.

The rolling auction with a single commitment length provides annual price signals to market participants, and in so doing provides more information than single auctions. The rolling auction with variable commitment length provides market participants with even more information. This configuration provides yearly price signals, and it provides these signals most often for more than one contract length. Market participants also get information from the relative prices of the various contract lengths.

The rolling auction with variable commitment length is expected to provide both frequent and reliable price signals. As in the rolling auction with a single commitment length, bidders do not have a choice of when to bid; a bidder that does not participate in a given auction foregoes the opportunity to provide resource for a one-year period three years into the future. For example, if a resource provider committed its resources on a three-year basis in the 2004 auction, but if the resource provider fails to participate in the 2007 auction, the resource provider will not be committing its resources for the year for the year June 1, 2010 to May 31, 2011. (The resource provider could not have participated in the 2006 auction as its resources were fully committed for the year June 1, 2009 to May 31, 2010). The bidding task does not suffer from the problems analyzed by the auction literature.

However, from the point of view of bidders, the market organization is more complex than in the case of the rolling auction with a single commitment length, and would require a more concerted effort to educate bidders. The flexibility in the commitment length is both an advantage in terms of the choices it provides, but a disadvantage in terms of the potential complexities of pursuing certain market strategies. A resource provider can always choose to pursue a simple strategy, such as always committing its resources for the same commitment length. For example, a resource provider could commit its entire resources in 2006 on a two-year basis, and could subsequently participate in an auction every two years to commit its resources again on a two-year basis. But a resource provider also has the possibility of pursuing a more diversified approach, providing a portion of its resources for different contract lengths. For example, a resource provider that, in the 2004 auction, committed half of its resources on a two-year basis and half of its resources on a three-year basis could next participate in the 2006 auction. In the 2006 auction, the resource provider could again commit its resources for a two-year period, or it could commit its resources for a one-year period. Resource providers can pursue a simple strategy of adopting a single commitment length, they can diversify with different commitment lengths, and they will always have the opportunity to change strategies at auctions in which various commitment lengths are offered.

The ISO determines the obligation on a yearly basis. The amount procured in a given auction is the portion of the obligation for the first year of the commitment period that has not yet been procured through previous auctions. We assume that this amount to be procured in a given auction is then divided equally among the various commitment lengths offered in that auction.

An example is provided in Figure 4.8 below. In 2007, the ISO determines the obligation for the year June 1, 2010 to May 31, 2011 to be 33,725 MW. Of this obligation, 11,100 MW was procured on a two-year commitment basis in an auction in 2006. Thus, 22,625 MW is procured in the 2007 auction. There are two commitment lengths offered in the 2007 auction, a one-year and a three-year commitment length, and 11,312.5 MW will be procured of each. When determining the amount to be procured in the 2008 auction, the ISO will consider this 11,312.5 MW procured in 2007 for the year June 1, 2011 to May 31, 2013, as well as the obligation for the year June 1, 2011 to May 31, 2012, which is assumed to be 34,003 MW. The amount procured in the 2008 auction is amount needed to meet the requirement for the year June 1, 2011 to May 31, 2012, which is 22,690.5 MW = 34,003 MW – 11,312.5 MW. This requirement will be divided among the two commitment lengths in the 2008 auction. The obligation for each year is procured through three different products, procured through auctions occurring at two different times.

Figure 4-8
Example of Amounts to be Procured.

Year and Obligation for year	Auction	Commitment Period	Amount Procured
June 1 2010 to May 31, 2011 33,725MW	Auction 2006	June 1 2009 to May 31, 2011 (two-year commitment)	11,100MW
	Auction 2007	June 1 2010 to May 31, 2011 (one-year commitment)	11,312.5 MW
	Auction 2007	June 1, 2010 to May 31, 2013 (three-year commitment)	11,312.5 MW
June 1 2011 to May 31, 2012 34,003MW	Auction 2007	June 1, 2010 to May 31, 2013 (three-year commitment)	11,312.5 MW
	Auction 2008	June 1 2011 to May 31, 2012 (one-year commitment)	11,345 MW
	Auction 2008	June 1 2011 to May 31, 2013 (two-year commitment)	11,345.5 MW

We have assumed that the obligation to be procured in a given auction is divided roughly equally between the products offered at that auction. There would be no harm in doing so as the relative prices of these two commitment lengths would adapt to reflect the preferences of the resource providers and the relative scarcity of these products. Assuming that the amount procured is divided equally among the products offered, the market is still relatively simple to administer, even through it is more complicated than for the rolling auction with a single commitment length. If the ISO wishes the allocation of the obligation among commitment lengths to be sensitive to the preferences of the resource providers or the needs of the market, the ISO may then need to put in place potentially complex tools to allocate the obligations among commitment lengths. This would increase significantly the burden of administering the market, and the complexity for bidders. Any perceived advantage of fine-tuning the allocation of the obligation among commitment lengths, given that such fine-tuning will be directly reflected in prices through competition at the auction, would need to be weighed carefully against potentially strong disadvantages.

4.3. Feedback from Stakeholders

There were two main comments from stakeholders:

- If there are to be variable commitment lengths, the market should be able to determine the amounts that should be procured for each commitment lengths;
- The rolling auction configuration is complicated, especially the rolling auction with a variable commitment length.

With respect to the first comment, the worry as expressed to us is that dividing the obligation equally among the products may not be appropriate to the preferences of resource providers. Certainly, if no resource providers wanted to commit resources for a period of three years under any circumstances, a three-year product would find no takers, and the ISO would not be able to meet its obligation without changing the mix of products. We believe, however, that it is more likely that, for many or even most resource providers, various commitment lengths are economic substitutes. That is, there is nothing from a technical or a financial standpoint that prevents these providers from committing resources for any one-commitment period and, at suitable prices, resource providers would be willing to accept any one of the commitment periods. The prices at which they would be willing to accept these commitment periods say something about their preferences – they would require greater compensation for a commitment period that works less smoothly with their business plan or corporate policies.

If our belief that various commitment lengths are economic substitutes in the sense presented above is correct, then different allocations of the requirement among various commitment lengths affect the demand-supply balance for each commitment length, and thus the final prices. They would not, except in extreme cases, result in a shortage of resources committed. Different allocations would result in different prices, and market participants would be the ultimate deciders of the appropriate relative prices among the various commitment lengths.

An alternative where market participants instead decide the appropriate mix of commitment periods is certainly possible. Providers would need to state their preferred commitment period when bidding. However, providers could only state this preference in a well-reasoned way if they knew the prices (at least the relative prices) among all commitment lengths. Thus, these relative prices cannot be determined by the auction, but instead must be set in advance. Leaving the mix of commitment lengths to the market, and having market participants decide the appropriate quantities of each, can only be done if the ISOs are willing to determine in advance the relative prices of the commitment lengths.

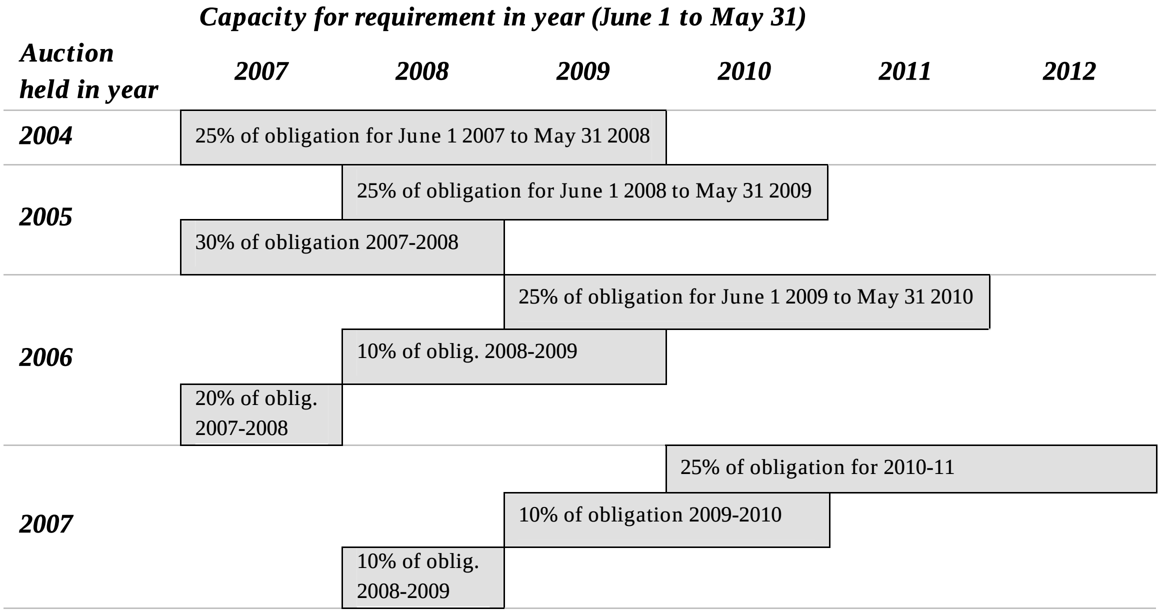
As emphasized earlier, if the ISO makes the determination of the mix of commitment lengths based on the feedback from market participants, they may enter into a complex exercise that will likely only shift relative prices, without any real effect in terms of enhancing participation or any guarantee of lowering the overall cost of procurement.

With respect to the second comment, it is certainly true that, compared to a single auction for a set commitment period, or even multiple auctions that each procure a percentage of the obligation for a set commitment period, a rolling auction configuration is a more unusual and seemingly complex way to organize the market. It seems to us the apparent complexity comes mainly from the fact that it is not immediately obvious how the ISO ensures that the full requirement for a given year is met, or how the amount procured in a given auction figures in the way the ISO determines the amount procured in a future auction. The mechanics of these determinations are not immediately obvious, but they are fairly simple once explained. We believe that from the point of view of bidders′ bidding task, rolling auctions do not present bidders with strategic complexity of the sort that would put the reliability of the price signal at risk. In short, we believe that the complexity of the rolling auctions is more apparent than real; the organization of the market should not pose particular difficulty for bidders or for the ISOs.

It is also worth noting that market participants have proposed alternative rolling auction arrangements to accommodate resource providers whose current business model is to commit resources a short time in advance and for a short period of time. The proposal submitted to us is considerably more complicated that the rolling auctions presented thus far, as it varies the commitment period, the planning horizon, and the percentage of the obligation that is procured for a given commitment period and planning horizon pair.

This proposal illustrates well the fact that are many other configurations that are more complex than what we have proposed and that stakeholders can certainly understand and work with these structures. In the proposal, illustrated below in Figure 4.9, each auction has three products, a one-year commitment period with a one-year planning horizon, a two-year commitment period with a two-year planning horizon, and a three-year commitment period with a three-year planning horizon.

Figure 4-9
Rolling Auction with Variable Commitment Period and Variable Planning Horizon.



This proposal, although it expands the choice of products for resource providers, also reintroduces the disadvantages of multiple auctions for a single commitment period. As we explained above, these disadvantages come about when a resource provider has the opportunity of deciding when to bid, and this complexity in the bidding task hampers the reliability of the price signal. In rolling auctions of the type we proposed, bidders do not have a choice of when to bid, because if a bidder chooses not to participate in a given auction, the bidder has forever foregone the opportunity to provide resources for a given time period. No future auction procures resources for that period again. In the proposal illustrated in the figure above, resource providers ***can*** decide when to bid. For example, a resource provider that chooses not to participate in the 2004 auction and not to commit its resources for the period from June 1, 2007 to May 31, 2010 through that auction can still participate in future auctions to commit its resources during that same period. The resource provider can participate in the 2005 auction and commit its resources for the period from June 1, 2007 to May 31, 2009, and then participate in the 2007 auction and commit its resources for the period June 1, 2009 to May 31, 2010. Providers may prefer the certainty of one contract, but the fact is that resource providers have a choice of different contracts that span exactly the same period and that are offered through different auctions at different times. Providers again can choose when to bid. We believe that this means that this proposal suffers from the same disadvantages as the multiple auctions for a given commitment period, and has the additional disadvantage of complexity.

4.4. Summary Assessment

<u>Conclusions and Recommendations</u>

1) We find that using multiple auctions for a set commitment period is not acceptable as it is unlikely to satisfy the goals of the ISOs.

2) We find that using a rolling auction with a fixed planning horizon is suitable to the goals of the ISOs, either with a single commitment period or with various commitment periods. A single commitment period maximizes the protection against the effects of transient events and simplifies the administration of the market. Various commitment periods maximize participation in the auction by providing more product choice for bidders and provide more frequent and varied price signals to the market.

3) Other more complicated rolling auctions could be considered. The proposal with both various commitment periods and various planning horizons reintroduce the distorting incentives of multiple auctions for a set commitment period and thus is unlikely to satisfy the goals of the ISOs.

4) A single auction for a set commitment period is an acceptable auction, which can satisfy the goals of the ISOs, but which may not fully promote confidence in the market through frequent price signals, or through price signals that are not shielded from the influence of transient events.

5. STRUCTURE OF CENTRAL AUCTION

NERA was asked to evaluate the benefits and drawbacks of a sealed bid 'reverse English auction', a sealed bid receive-as-offer auction, and a descending clock auction. NERA was also asked to analyze whether any other auction format would be more appropriate for CRAM.

On balance, NERA recommends a descending clock auction format. A descending clock auction best addresses the decision-making problem that bidders face when they enter the auction. By helping bidders in their decision making process, they can be expected to bid less conservatively and the ISOs' objectives are likely to be accomplished more readily. The final price can be expected to be a more reliable signal for adequacy, in the sense that it would reflect the price required for entry to occur in the commitment period and for existing resources to be available.

Much of our assessment fundamentally relies on the fact that a clock auction is an open auction format with multiple rounds. In an open auction with multiple rounds, bidders can react to other bidders' bids by updating their valuations[6]. There is ample evidence that bidders do indeed adjust how much they are willing to bid over the course of an open auction. Very often, the financial decision makers are updated on the progress of the auction. In discussion with the auction team, they revise their valuations and willingness to bid at given price levels on seeing indicators of other bidders' bids.

The second fundamental benefit of a multiple round auction is that it can accommodate more than one product, and can allow bidders to switch between these products as relative prices change. In this way, the auction format can, for example, allow for the possibility of zonal capacity prices. Also, the auction format can take into account transmission constraints in an elegant and simple way. We provide an example of a clock auction in the next section to illustrate this property.

An auction, or any bidding mechanism, is only as successful as the level of competition among bidders will allow. If bidders coordinate (***implicit collusion***) to achieve a high price, usually by reducing the quantity they bid, then the auction would end with a price that is not an appropriate signal for adequacy. One of the criteria for our auction format recommendation is that the auction format be sufficiently robust and flexible against collusion. How a clock auction fares against collusion is described in section 5.3.5. In addition to basing our choice of auction format on its competitive properties, we recommend additional rules that offer additional protection again potential coordination by bidders, and thus provide additional incentives for competition. These additional measures are described in section 7.3.5.

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[6] By valuation we mean the value of committing resources in an ISO that emerges from a long run business plan.

In the remainder of this section, we first give a description of a clock auction format. We proceed by presenting our approach for selecting a preferred auction format. In the main body of the section, we explain in detail what we think the key drivers are that should determine the auction format.

5.1. Description of a Descending Clock Auction

A descending clock auction belongs to the family of simultaneous multiple round auctions. It works in a similar way to an art house auction at Sotheby's or Christie's. The auctioneer announces a price, called the 'going price'. Bidders submit bid quantities in MW at that price. Bidders are given time, usually between 15 minutes and a few hours, to decide how much to bid. The time they are given to bid is called a 'round'. Following the end of a round, the auctioneer adds up all bids at the going price. If the number of MW bid is more than the number of MW required, the auctioneer lowers the going price for the following round – the 'clock ticks down'. Bidders again decide how much to bid at the lower price. When the total amount of MWs submitted is just as large as the total amount of MWs demanded, the auction closes. The winners are the bidders in the last round of the auction.

In contrast to an art house auction (or an e-bay auction), in which a bidder can jump in at a late stage in the auction, bidders in the clock auction must submit bids in every round, and the number of MWs they submit can never be larger than the number of MWs they submitted in a previous round.

The basic format extends easily to allow for multiple zones characterized by capacity deliverability considerations. Suppose there is a zone A and a zone B. Suppose also that a company is thinking of entering the market either in A or in B, but not in both. It has already submitted planning applications for both zones, but intends to proceed to build only if it wins in the auction, and only in the more profitable zone. There is no way for the company to know before the auction which of the zones will have the more attractive clearing price.

The clock auction accommodates multiple zones or multiple products by running several simultaneous clocks that tick down at different speeds, depending on the excess supply for each of them. For example, if there is excess supply in zone A but not in zone B, the going price for zone A will be lowered in the subsequent round, but the price for zone B will stay the same.

Bidders are still not allowed to bid more in a round than they bid in a previous round. But this restriction is only valid for the whole auction and not for each zone. Subject to not creating aggregate excess demand, bidders are allowed to switch their bids from zone A to zone B and then switch back in a later round if they wish. In this way, the market will determine the relative prices between A and B and the entrant can make an informed decision as to where to build the plant. The auction only closes when there is no excess supply in either zone A or zone B.

The clock auction also allows for various arrangements regarding the dissemination of information in the auction. For example, all bid information of all bidders could be published. Alternatively, only the going prices in each zone / on each product could be published. Many intermediate forms of information dissemination can be thought of. How much information should be published, and in which form, is subject of our discussion on market monitoring and mitigation (section 7.3.5).

Lastly, the clock auction allows for the bidding by LSEs of bilateral contracts. Bidders can bid the capacity associated with those contracts into the auction at the going price, regardless of what the going price is. The fact that the descending clock auction is a uniform price auction means that they will get the same capacity payment as all other winning bidders. We elaborate on the point of uniform v. receive-as-offer auctions in section 5.2.1.

Example 1: A numerical example of a clock auction

In the following we provide a simple example of the mechanics of a clock auction. Suppose that, for the sake of illustration, the auctioneer is PJM. There is no restriction on the participation of bidders. However, PJM needs to take into account that transmission constraints exist from PJM to the NY-ISO and from PJM to ISO-NE. Suppose for simplicity that there are no other entry points into the PJM area. Additional points can be accommodated in the same manner, but would only clutter the example without adding any additional insight.

PJM creates three products: product 'PJM' is open to bidders with generation inside of the PJM area. Product 'NY-PJM' is open to bidders who would like to provide capacity to PJM but have their generation units inside the NY-ISO area, ***plus*** all bidders with generation inside the PJM area. Product 'NE-PJM' is open to bidders with generation inside the NE area, ***plus*** all bidders with generation inside the PJM area.

Suppose that there is sufficient interest in the auction by generators, and that the starting price of the auction is set at $220/kW-year for each of the three products. Suppose that the total requirement is equal to 70,000 MW, split in the following way: 60,000 MW for product 'PJM', 7,000 MW for 'NY-PJM' and 3,000 MW for 'NE-PJM'. The summary measures for round 1 of the auction are:

Table 5.1
Summary measures for Round 1

Round 1Bid Submission	PJM (60, 000 MW)	NY-PJM (7,000 MW)	NE-PJM (3,000 MW)
Round 1 Price	$220/kW-year	$220/kW-year	$220/kW-year
Round 1 Total bids	69,890 MW	8,870 MW	2,780 MW

Only the auctioneer sees bid submissions by bidders as and when they enter their bids. Bidders only see the information selected for them in a bidder report, which the auctioneer publishes following the end of each round.

It turns out that in round 1 there is excess supply on PJM (9,890 MW of excess supply) and NY-PJM (1,870 MW), but there is no excess supply on NE-PJM (220 MW shortfall). Total aggregate supply is 81,540 MW so that total aggregate excess supply is 11,540 MW. Therefore, prices decrease for PJM and NY-PJM, but remain at the round 1 level for NE-PJM. Bidders receive the following bid report:

Table 5.2
Bid Report for Round 1

Round 1 Report	PJM (60, 000 MW)	NY-PJM (7,000 MW)	NE-PJM (3,000 MW)
Round 1 Price	$220/kW-year	$220/kW-year	$220/kW-year
Round 2 Price	$198/kW-year	$208/kW-year	$220/kW-year
Excess Supply	In excess of 10,000 MW		

There is a wealth of information generated by bids in the first round, including individual bids on each product, their time of submission, the reduction of bid amounts or 'eligibility' with respect to the qualified bid amount. Analyzing the data would reveal additional insights: for example, if PJM bidders bid on NY-PJM and NE-PJM products, how many entrants are participating, how large the entrants are, etc. The decision of which subset of all available information to provide to bidders is an auction rule that must be carefully set. In our example, only new prices for individual products and a measure of aggregate supply are revealed, in keeping with our recommendations in section 7.3.5.

Since PJM bidders are allowed to bid on all three products, some may switch to NE-PJM, as the price for that product remains at 220 $/kW-year, while the price on PJM has fallen to 198 $/kw-year. Bid submission for round 2 is as follows.

Table 5.3
Bid Submission for Round 2

Round 2 Bid Submission	PJM (60, 000 MW)	NY-PJM (7,000 MW)	NE-PJM (3,000 MW)
Round 2 Price	$198 / kW-year	$208 / kW-year	$220 / kW-year
Round 2 Total bids	68,850 MW	7,890 MW	3,320 MW

Total aggregate supply falls from 81,450 MW to 80,060 MW. Total bids on PJM decrease from 69,890 MW to 68,850 MW. On NY-PJM bid amounts are reduced from 8,870 MW to 7,890 MW. On NE-PJM the quantities bid increase from 2,780 MW to 3,320 MW. In our example the changes in bids are due to a switch by one bidder of 540 MW from PJM to NE-PJM, and by reductions by other bidders. Recall that bidders can never increase the amount they bid from one round to the next.

While round 2 sees a reduction in the total quantity bid, the increase in bid quantity on NE-PJM means that, in contrast to round 1, there is excess supply on all three products. The auctioneer will therefore lower the prices on all products for round 3.

In general, an auctioneer would wish to impose some restriction on how much bidders can reduce their bids and how bidders can switch from one product to another. In most implementations of a clock auction, including in our proposal, the auctioneer would restrict bid reductions and switches such that a product will not drop from a state of excess supply to one of shortage. For example, if the 540 MW switch in our example from PJM to NE-PJM would have resulted in shortage on the PJM product, then that switch would not have been allowed by the auctioneer.

The auction finishes when there is no excess supply on any product. As long as there is excess supply on at least one product, the auction continues and prices decrease on the products with excess supply.

Due to the possible lumpiness of bids, it may happen that at the end of the auction one would move from a state of excess supply to excess demand. In our example, total excess supply on PJM in round 55 is 60,120 MW. In round 56 three bidders wish to withdraw a total of 300 MW and so the auction would end up in a situation of excess demand. What is needed is a rule for retaining enough quantity to fill the demand of 60,000 MW, and an associated rationing rule that determines how much of each bidders' supply would be part of the final demand. One such rule could be that bidders submit 'exit bids', also sometimes called 'last and best bids'. Those bids can be bid at any price between the previous round going price and the current round going price. This is illustrated in the next table.

Table 5.4
Final two rounds of the auction

	PJM (60, 000 MW)	NY-PJM (7,000 MW)	NE-PJM (3,000 MW)
Round 55 prices	$75/kW-year	$74/kW-year	$74.50/kW-year
Round 55 bid submissions	60,120 MW	7,000 MW	3,000 MW
Round 56 prices	$74.50/kW-year	$74/kW-year	$74.50/kW-year
Round 56 bid submissions	59,820 MW 300 MW exit bids @ 74.60 $/kW-year	7,000 MW	3,000 MW
Round 56 bid report	59,820 MW @ 74.50$/MW-day 180 MW at @ 74.60 $/MW-day	7,000 MW	3,000 MW
	Auction closes		

Three bidders submitted exit bids for a total of 300 MW at 74.60 $/MW-day. The auctioneer wishes to retain 180 MW of the total of 300 MW in order to fill the target demand of 60,000 MW. Different rationing rules can be designed. Either rationing is proportional (a share of each bidders' bids is accepted), or rationing is random (one or more of the bidders is chosen at random), or rationing is according to some other criterion such as size. The auction format is also flexible enough to allow for lumpy bids. Lumpy bids would imply that bidders' bids would not be partially filled. Either a bidder's bid is fully filled or it is not filled at all. The ISO would then need to accept that the requirement set at the start of the auction would be filled within a band. In several other occasions in this report (see section 3.3 and section 7.3.4) we have argued that a rule on lumpiness of bids may be beneficial both for reasons of competitiveness as well as to accommodate fixed plant sizes.

The auction closes after the end of round 56. The highest accepted price on each product is paid to all winning bidders. The final price for PJM would be $74.60/MW-day, for NY-PJM it would be $74.00/MW-day and for NE-PJM it would be $74.50/MW-day. This finishes our example[7].

5.1.1. A Note on Coordination by the ISOs

In the example provided in this section above, prices are expected to equilibrate among the various products. Resource providers in PJM can arbitrage the prices and make sure that any

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[7] See Memorandum from Mike Cadwalader to Centralized ICAP Markets Working Group, Regarding Simultaneous Descending Clock Auction for ICAP, April 16, 2002.

price differences only reflect differences in the willingness to commit resources from the providers in various regions. This occurs because bidders can switch their bids and can, in real time, compare the opportunities that are afforded by each type of product.

Similarly, if all ISOs were to procure their requirements through a single process, in which bidders could switch their bids from one product to another, any differences in the closing prices would only reflect differences in the opportunity of committing resources to different regions and the competition that exists in the various regions. (As in the example above, bidders would be qualified to bid on certain products but not others). The prices would provide good signals for adequacy. There would be other advantages as well:

- The competition at the auction would benefit from all providers being participating in a single event;
- Each bidder could select its best product match;
- Bidders could obtain valuable information on bidding in regions other than the region they intended to bid on.

These benefits accrue to the bidders and the auction as long as bidders can switch among the products offered. This would require that the ISOs adopt the same auction format, run each round of the auction at the same time, and allow information about one ISO to flow to bidders from another ISO. It would not require that all ISOs adopt the same elements of the CRAM, including common qualification procedures, whether or not to use the variable resource requirement, or identical credit requirements (although if such elements were common to all ISOs, it would make the opportunity easy to evaluate for bidders and it would reduce their cost of participation at the auction).

If auctions are held concurrently but switching is not allowed, as the RAM Group has initially envisaged, then not many of the benefits of coordination are preserved. Although all auctions start at the same time, they finish independently. When bidding stops in one auction, it cannot restart. Unavoidably one auction finishes first, but another auction can continue for a long time. Bidders do not know in advance which auction will close first and bidders can no longer update their bids in the first auction to close based on the subsequent results of the later auctions. Prices can be widely disparate, in a way that does not provide the best signal for adequacy.

The Public Utility Commission of Texas (PUCT) mandated such concurrent auctions for capacity for three of its utilities. In the face of price dispersion among products that should have had similar prices, (prices for identical products were as much as 40% apart), the PUCT subsequently adopted a rule that allowed bidders to see the results from the products and that allowed to revise their bids on that basis. Even though the credit requirements and price change rules were different, bidders were able to see the prices in the other auctions and bid lower in any auction if they learned anything from any of the auctions. Prices equilibrated.

NERA recognizes that a single auction process is not a realistic goal at present for the ISOs. Nevertheless, NERA notes the substantial benefits that would exist for all ISOs to allow bidders to switch and to revise their bids in one ISO on the basis of the auction results in another ISO.

5.2. Arriving at a Our Recommendation of a Descending Clock Auction

We arrive at our recommendation on the auction format through a thorough research process. The first step of our research process is to describe as fully as possible the decision that a resource provider faces when entering into the auction, and the objectives that the CRAM auctioneer (the ISO) has when procuring the capacity.

We then distill the complexities of the resource providers' and the auctioneer's decision problem ('how much to bid at what price') into the language of auction theory. We find that the salient features of the decision problems are:

- ***Common Value Uncertainty and Affiliation of Values***: Resource providers face common sources of uncertainty regarding the future. Each resource provider has uncertainty about future revenues in the energy and ancillary service markets and uncertainty as to future capacity markets. Individual bidders may have different information about the demand-supply balance in the energy and ancillary service markets, different expectations on market revenues, and may have different opinions regarding the outcome of future capacity markets. A capacity auction should be designed in such a way that it helps to aggregate the diverse information held by resource providers.

  Related to common values are 'affiliated values'. Loosely speaking, by affiliated values auction theory means value distributions that have the same shapes, but not necessarily the same reasons. If values between bidders are affiliated, then roughly speaking, high values for one bidder implies that another bidder is more likely to have high values as well. An example would be demand for energy by the financial sector in New York City, and demand for energy by the tourist sector in New York. If a resource provider sees strong demand from the financial sector, then another resource provider is likely to strong demand from the tourist sector. We think that this effect is also important. Resource providers will base their estimates of revenues in the energy market on the ISO's forecast but also on information from their own transactions. If they serve different customer classes or sectors, then affiliated values imply that the auction format should ensure that the link between the classes would be used for the benefit of the auction.

- ***An Entry-Smoothing Problem***: Even if the level of future demand and the need for potential new capacity are known, a mechanism for identifying who is committed to enter the market is valuable. Otherwise, either too many, or too few suppliers might enter the market. This concern is important for both the ISOs and the bidders. The auction should attempt to address the boom-bust cycle of too much and too little entry.
- ***Asymmetry of bidders:*** Even if the level of future demand, and the need for capacity, is known, it may not be known which bidder could provide this capacity most efficiently. One goal is for the auction to identify the most efficient providers.
- ***Completing the Market System:*** Another purpose of the creation of a capacity market that operates a long time in advance is simply to add a market for a particular forward contract to the market system. The hope is that adding this market on a forward basis will increase efficiency by allowing new trades to occur in this market.

We subsequently translated these concerns into auction theory and consulted a very large body of literature about the format that would best address these questions. The principles that we followed were:

- Auction theory proceeds on the basis of buying. We translate the lessons to selling.
- Auction theory, on advising on an auction format, uses the following principles:
    - Providing information to bidders who face uncertainty makes them bid more confidently.
    - Providing information to bidders reduces the risk of the winner′s curse.
    - If the views that bidders have of the value of capacity are ′affiliated′, then an open format performs better (the ′linkage principle′).
    - Using an open auction promotes the selection of the most efficient provider.
    - In a sealed bid format, entrants can use uncertainty to their advantage in the face of strong incumbents.
    - In a closed uniform price auction, there are well-known ways for bidders to coordinate.
    - In a closed uniform price auction with smooth supply functions and reasonable assumptions on information, a wide range of prices can occur.
    - The price resulting from pay-as-bid auction can be unpredictable.

  - In an open auction, coordination is easy if there are two bidders who know each other's value for capacity. If there are more bidders and the value is uncertain, coordination in an open auction becomes very difficult.

- The auction literature, on advising on an auction format, leans on the following practical experience:
  - Spectrum auctions, in particular for the experience with open auctions.
  - Treasury auctions, in particular for the discussion of uniform versus pay-as-bid auctions.
  - Other energy auctions, in particular for the experience with clock auction formats and the experience of sealed bid auctions.

- We consulted ISO data:
  - We assessed the competitiveness of all PJM and a selection of NY-ISO short-term capacity auctions.
  - We assessed the concerns of the market monitoring reports for PJM, NY-ISO and NE-ISO.

Having selected a descending clock auction as a candidate format on the basis of the principles that we extracted from the applicable auction theory, we then proceeded to analyze whether in the three ISO markets at hand, such an auction format would be workable. In particular, we analyzed whether the descending clock auction has desirable competitive effects.

Following the analysis and recommendation of the auction design, we then proceeded to spend much time and energy into attempting to find ways in which the descending clock auction can be supplemented with measures that ensure the competition in the auction and that will allow a fair price to emerge.

In this section, we illustrate the arguments that led us to decide in favor of a descending clock auction. The section on monitoring and mitigation (section 7) as well as the section on the VRR (section 8) will explain the additional measures that we believe should supplement the format. The section on the relationship between the capacity auction and the energy market explains the effect that bidding in the capacity auction should have on net revenue of a resource provider. In the appendix we list a number of other auction formats that we regarded as undesirable (Appendix B), and we also provide a section on the whole universe of possible auction formats that were considered for this report (Appendix A).

5.2.1. A Note On Pay-As-Bid Auctions

Generally speaking, a clock auction is a uniform price auction. The auction closes at the same price for everyone[8]. The auction stops at the point at which the supplier with the lowest price among the losing suppliers drops out. It is quite easy to see that it would not make sense to continue the auction afterwards: if the price were dropped further despite the fact that there was no excess supply, then all remaining bidders could exit the auction, knowing that the auctioneer would need to 'retain' their bids in order to fill his demand.

In a sealed bid auction, the distinction between pay-as-bid and uniform auctions matters very much, as bidders cannot react to each other's bids and converge toward a market price. Bidders may submit radically different offers. Would these auctions receive-as-offer auctions lead to lower prices than uniform price auctions?

The empirical evidence is inconclusive and anecdotal. Theoretically, this question has received significant attention in the context of Treasury auctions. Recently, the US Treasury started selling off index-linked bonds in a uniform price auction. Previously, all US Treasury auctions were of the discriminatory kind. An excellent and very approachable account of the discriminatory v. uniform price auction debate can be found in Binmore and Swierbinski (2000)[9].

The difference between uniform and discriminatory auctions can be explained quite simply: what is important in an auction is not the value of a bidder's bid, but instead the value of the bid that the bidder needs to beat. Suppose that a bidder has capacity costs of 10 $/kW-year, but the bidder knows that the only other bidder has capacity costs of 25 $/kW-year. Then the first bidder can be certain to win by bidding just under 25 $/kW-year. Suppose now that both bidders bid several hundreds of MWs of capacity. Then, in a receive-as-offer auction, each MW would compete with each other MW. Bidders would understand that each MW only needs to beat their competitors MWs and therefore increase the bid on each MW to just below what they expect the competitor to bid. In contrast, in a uniform price auction all that matters is the 'marginal' unit, i.e. the highest winning unit. Bidders only compete on the highest winning unit and not on all other units. Therefore they can bid lower on all 'inframarginal' units, since those units do not determine the price. Since bidders in this way adjust their inframarginal units to the rules, the outcome in terms of revenue is unclear.

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[8] Strictly speaking, one could have a pricing rule in which the final prices for bidders need not be exactly the same, but they will always lie within one decrement (within a small percentage). We recommend that all bidders be paid exactly the same price.

[9] K. Binmore, J. Swierzbinski, (2000), ***Treasury auctions: Uniform or Discriminatory?***, Review of Economic Design 5, 387-410

The fact that a uniform price auction only relies on competition for the marginal unit makes it much simpler strategically. In particular, if bidders have large components of 'must run' in the power plant portfolio, or a large number of bilateral contracts, they could bid all the corresponding MWs into the auction by bidding zero. They would still get the same price for all those units. In a sense, those bids could be seen as 'price taking bids'. In contrast, in a receive-as-offer auction, the bidders would attempt to estimate all other bidders' supply curves and try to bid as high as possible while still ensuring that their 'must run' or bilaterals are auction winners. This bidding problem is strategically significantly more difficult. In this context, "must run" refers to capacity that would be committed to the market at any price.

It is very difficult to compare the competitive nature of discriminatory and uniform price auctions. This is due to a very technical complexity in the analysis of discriminatory auctions. Those auctions often only have equilibria in so-called 'mixed strategies'. This type of equilibria is not regarded as being convincing descriptions of real world bidding behavior. If one compares these equilibria with the equilibria in uniform price auctions, it emerges that both auction formats allow for collusive bidding but it is not clear which one is likely to be less 'collusive'.[10]

Given the two reasons of ambiguous evidence of revenues (i.e., the choice of uniform price versus pay as bid would not change the price expectation) and the strategic simplicity of uniform price auctions, we would have recommended a uniform price format over a sealed bid auction. We therefore find support for our recommendation of an open descending clock auction, which is inherently a uniform price auction.

5.3. Key Drivers for the Decision on the Auction Format

When translating the bidders' and the ISOs' CRAM decision problems into auction theory, we arrived at the four concepts we discussed earlier as key drivers for our recommendation on the auction format. In the section we discuss in depth these four drivers of our recommendation. In taking the decision that these four issues were the key drivers that needed to be considered in the recommendation of the auction format, we also acknowledged that other factors were less important. Those factors were:

- We did not think that a main driver for the format should be that there is a lack of potential entry.
- By analyzing the market structure of the ISOs, we understood that there are several sizeable players in two of the three markets, and that the shares of the largest firms in all

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[10] Ubeda, ***Capacity and Market Design, Discriminatory v. Uniform Auctions***, mimeo, Universidad Carlos III de Madrid.

markets are not so high that it would be obvious that the largest firm will set the price. It is sometimes proposed, in particular in the recent writings of P. Klemperer,[11] that if there is a large firm that could be expected to dominate an auction, the auction format should be such to give that firm a lot of uncertainty about who else participates in the auction and what the excess supply is. By 'scaring' the large incumbent, price discipline is imposed. We did not think that, on balance, potential benefits of such a feature would outweigh that bidders would not be allowed to learn from such measures as aggregate excess supply.

- Information revelation may not be needed, since bidders in the second auction can learn from the results of the first auction. We believe that the infrequency of the auctions mean that the burden on information generation shifts from the auction results to the auction process itself.
- The auction needs to finish within a very short time period. While we believe that speed is important, we also think that given the time horizon it should be acceptable to bidders to participate in an auction that may last several days.
- We do evaluate in a separate section the introduction of a variable resource requirement. As we will demonstrate, however, we believe that the use of a variable resource requirement is independent of the auction format chosen.

We now present our reasoning on the four key drivers and illustrate how those drivers lead us to recommend a descending clock auction.

5.3.1. Common Value Uncertainty and Affiliation

By 'common value' auction theory means that all bidders are estimating a value, which is common, for example the anticipated revenues in the energy and ancillary service markets, or the regulatory uncertainty that would be faced by all resource providers. The concern of common values can best be captured under the heading of the 'winner's curse'.

5.3.1.1. Winner's curse in common value auctions

The winner's curse refers to the phenomenon by which winning in an auction can be "bad news". To give a simple example, suppose a group of bidders are bidding on a jar of pennies. There are $8.77 in the jar, but bidders are not allowed to spend enough time with the jar to be able to count. If each bidder, reasonably enough, submits as a bid an estimate of the amount of money in the jar, one would expect that on average, half of them will have overbid and half will

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[11] Klemperer (2002) "What really matters in auction design", ***Journal of Economic Perspectives***.

have underbid. Perhaps the bids were: $15, $12.88, $10, $8.50, $7.98 $6.22, $3.14. But this means that when a particular bidder learns that he is the winner of the auction, he learns that he is the one who has most overbid for the jar. The announcement that he has won will be bad news: he now must pay $15 for $8.77 worth of pennies!

The important lesson here is that bidders should realize that winning carries the curse of having been the most optimistic. They do so by adjusting their bid to take into account this effect. For example, to guard against the possibility that they will have been too optimistic regarding energy market revenues, bidders should increase their bid in the CRAM to alleviate this risk.

In an open auction format, information will be provided to bidders (no such information would be provided in a sealed bid auction). Bidders learn valuable information about other bidders' estimates as the auction proceeds and bidders drop out. The ability to condition expectations on more information generally leads to more precise estimates and makes bidders more willing to bid aggressively. For example, if the jar of pennies had been sold using an open auction format, the winning bidder would have seen that someone had become unwilling to bid once the price went above $3.15 or so, and would have changed his estimate of $15 on that basis.

Example

Suppose that a potential entrant estimates that he can enter the market and expect to break even with a capacity payment of $50/kW-year. The entrant recognizes that this estimate is very imprecise since it is based on expectations on future energy market revenues and that incumbents arguably are better informed. Suppose capacity is procured in an open auction, e.g. a descending clock-auction. Based on the entrant's knowledge of rival bidders' cost structure he expects excess supply in the auction to be around 5% when the price reaches $55/kW-year. However, when the price in the capacity auction reaches $55/kW-year, the entrant observes that there is still considerable excess supply, say 15%. This observation may lead the potential entrant to revise his expectation of future revenues in the energy market and stay in the auction until the price reaches, say, $40/kW-year. The fact that rival bidders are more optimistic about future energy market revenues, and therefore supplies more than expected in the capacity auction, means that the entrant's estimate is probably too pessimistic. In a sealed bid auction, such a revision of expectations would not be possible.

5.3.1.2. Affiliation

One of the well established principles in auction theory is the so-called 'linkage principle'. If values of bidders are affiliated, then revealing those values to other bidders is beneficial for the auctioneer. In other words, if values are affiliated, then an auctioneer should choose to run an open auction.

'Affiliated' values means that positive influences on values for capacity are correlated. If one bidder should bid high at the auction given its expectations of the future, then another should as well. By revealing some information regarding the bidding behavior of one provider, another provider can readjust its own valuation. That mechanism only functions properly in a setting with multiple rounds.

5.3.2. Uncertainty Over who is the Least-Cost Generator

The markets in all three areas are characterized by differences in the size of resource providers. They can also be expected to show differences in the cost efficiency of resource providers. The cost differences will manifest itself in an auction outcome where not every resource provider will be a winner.

An auction that manages to select the least-cost or most efficient resource providers as winners is called an 'efficient' auction. It is perhaps important to emphasize that efficiency refers to the identity of the winner and not necessarily to the price that is being achieved in the auction. An open auction will typically lead to an efficient result, while a sealed bid auction does not lead to the same level of certainty regarding the efficiency of the outcome.[12]

In a sealed bid auction, a bidder bases his bid at least in part on the expectation of what his rivals will bid, and for that reason a bidder will not necessarily bid as low as he could have. To take an example, suppose that there are only two bidders. Bidder A thinks that the lowest bidder B is willing to bid is somewhere between $50 and $60, and suppose bidder B thinks the same of bidder A. Bidder A, in actual fact, cannot possibly bid less that $52 given Bidder A's expectations of future revenues and his going-forward costs. Bidder A could bid $52 and maximize his chances of winning – he will win as long as Bidder B bids above $52. But Bidder A could improve his profits by bidding higher, and he does so at the cost of decreasing his probability of winning. By bidding $53, his profit increases, but he will only win as long as Bidder B bids above $53. Bidder A trades off the probability of winning with the profit made on each unit, given an expectation of a bid by Bidder B. It can be shown that calculating this trade-off will yield an optimal bidding strategy of $56. If both bidders are reasonably similar, both bidders will calculate their bid based on the expectation of what the rivals will bid in the same, and the result will be efficient.

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[12] The arguments in this section are based on a series of articles by Maskin and Riley: Maskin and Riley (2000) "Asymmetric auctions" ***Review of Economic Studies***, 67, 413-438. Maskin and Riley (2000) "Equilibrium in sealed high bid auctions", ***Review of Economic Studies***, 67, 439-454. The distinction between efficiency and optimality is explained well in Ausubel, L. and Peter Cramton (1999) "The Optimality of Being Efficient", discussion paper, University of Maryland.

However, when bidders are sufficiently different, a sealed bid auction will not yield an efficient result. In our previous example, if the lowest Bidder A would be willing to bid is somewhere between $50 and $55, but the lowest Bidder B is willing to bid is between $50 and $70, then Bidder A faces significantly more uncertainty in guessing the possible bid of its rival. The effect is that Bidder A will be forced to bid 'more aggressively', i.e., closer to his true minimum than Bidder A is willing to bid. As a result, it may well be the case that, since A bids more aggressively than B, A's bid is lower than B's despite the fact that B has a lower cost. The bidder with the highest cost would win and the outcome would be inefficient.

In an open auction, the more efficient, least-cost resource provider can simply wait for the less efficient resource provider to withdraw from the auction. No guessing is required before hand that could result in the "wrong" resource provider winning. More aggressive bidding behavior on the part of the less efficient resource provider can always be countered by the patience of the more efficient bidder.

Therefore, with efficiency concerns as the objective of the auction, the presence of value asymmetries between bidders is a strong argument for the use of open auctions.[13]

If some bidders are more efficient than others, then a descending multiple round auction will select the most efficient bidders as winners of the auction. This is not necessarily the case in a sealed bid supply schedule auction. In a sealed bid auction with more and less efficient bidders, the less efficient bidders win with a positive probability.

5.3.3. Capacity Auctions to Complete Missing Markets

It could be argued that the problem, which the proposed capacity auctions are designed to address, is that there is a 'missing market'. A missing market is a description of the fact that some goods cannot be purchased (1) in advance or (2) for a particular contingency[14]. A concrete example for the case at hand would be the impossibility to buy capacity today for use on July 31, 2006 between 2 PM and 2:30 PM if temperatures exceed 100F.

The fact that some markets are missing does not allow companies to share risks in a most efficient way. For example, energy customers may be willing to pay some money to energy producers to ensure that there will be sufficient capacity if there is a very hot day several years

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[13] P. Klemperer, 'What really matters in Auction Design', ***Journal of Economic Perspectives***, 2003 has argued that less efficient bidders will not show up at the auction resulting in a higher market-clearing price. We do not believe that this deterrent on participation would be operative in the CRAM.

[14] The seminal work on missing markets is M. Magill and M. Quinzii (1996), ***Theory of Incomplete Markets***, MIT Press

later, but no institutional marketplace is there that would allow for such a transaction. Therefore, energy producers would need to make the decision to invest themselves and bear all the risk of the investment (the risk that the capacity will not be used). They may not be willing to carry the risk and, if they cannot find anyone to sell the risk to, they may decide against building new capacity.

Of course, one may immediately ask whether, if there is a profit opportunity, someone would not create such a market. However, creating a market is a relatively complicated activity (as evidenced by this report). The market situation, both from a cost and a competition point of view needs to be understood to find the best design for such a market. Moreover, the market institution needs to be credible and strong enough to attract sufficient interest in its use as a trading platform. Only if many companies, both buyers and sellers, commit to the trading platform can liquidity ensure that the established market mechanisms will not be abused. The risk of abuse, in turn, lessens the attractiveness of relying on such a market mechanism for potential participants.

These problems have empirically often led to the creation of markets that are themselves not very profitable and that are owned, or at least heavily influenced, by the participants of the markets. The New York Stock Exchange is such an example. Despite its enormous trading volumes of usually far in excess of 1 billion shares per day, the stock exchange itself is not very profitable. Presumably, if it tried to increase its profits by increasing commissions, its participants would move to other exchanges or would set up their own exchange.

It is also difficult for existing exchanges to introduce new contracts. One may argue, for example, that long-term capacity contracts could be traded on one of the Chicago commodity markets or by an independent energy exchange. However, several of the same obstacles as for establishing exchanges themselves can be encountered in introducing new contracts.[15] In particular, the liquidity question and the fact that a new market may affect all the existing profit opportunities in, sometimes, unpredictable ways are reasons often cited for the continued absence of markets.

Given the difficulties that companies or independent exchanges would find themselves in when attempting to introduce a new contract for capacity, it can be argued that the absence of a market for capacity does not mean that it would not be beneficial, and that the natural home for such a marketplace would be the ISOs.

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[15] An excellent exposition of economic literature on this topic can be found, for example, in a special issue of the Journal of Economic Theory on this subject, eds. D. Duffie and R. Rahi (1995).

The reasons for why a market is missing gives guidance to how such a market should be constructed. In the following paragraph, we investigate what can be learned from the non-existence of the market for the best possible capacity auction design.

5.3.3.1. Auction Format for Missing Markets

The first insight into missing markets for the future delivery of energy is that, just like every future commodity market, the market can be decomposed into a ***financial*** market and a ***spot commodity*** market. Instead of dealing in a contract which is written today and delivers an amount of energy for certain on July 31, 2006 between 2 PM and 2:30 PM if temperatures exceed 100F, it is equivalent to deal in a financial contract written today which pays off an amount of money on July 30, 2006 sufficiently high to purchase energy in the day-ahead spot market for delivery on July 31, 2006 between 2 PM and 2:30 PM if temperatures exceed 100F.

The financial futures contract is risky since it is not clear how much it will need to pay on July 30 to allow for the purchase of day-ahead spot energy. The resource provider may not be willing to bear that risk. Instead, it would like to receive the certainty equivalent of the risk payout of the contract. In effect, the capacity auctions provide such a certainty equivalent.

When a bidder wins a capacity auction contract, it receives money for certain, independently of whether the capacity will be needed in the period of commitment or not. The capacity auction is the mechanism by which the risk will be priced. Barring collusion and irregular market behavior the price in the capacity auction will be equal to the equilibrium estimate of the price of capacity that cannot be recovered in the day-ahead spot energy auction.

It is important to note, however, that the capacity auction only allows for a transfer of capacity risk, it does not in any way reduce that risk. The efficiency gain comes from allowing parties to bear the risk that are better suited to doing so, and not from reducing the overall risk in the energy market. This fact may be pointedly paraphrased by saying that 'the capacity auction does not change the weather'.

Suppose we consider briefly again the decision that a generator faces when deciding whether to build capacity. Suppose that the generator has solved all other issues such as its cost projections, likely behavior of competitors and demand estimates to its own satisfaction. The generator has therefore arrived at a certainty equivalent of the likely revenue stream of its own investment and has decided that on the basis of the estimate it would like to build new capacity.

The generator will at this point face the problem of presenting its case to financial backers, be they its shareholders and the stock market, a bank or the fixed income market. The problem may arise that the outside financial backers do not have sufficient information for determining whether the estimated future energy price and demand quantities are indeed reasonable estimates.

The auction solves the problem of verifying the financial viability of the proposal of the generator. The market introduced by the auction guarantees a certain payment for the operator that provides capacity. There is therefore no payment risk in the contract. However, the risk has not disappeared but is imposed on the energy suppliers who supply the energy in the spot market. The energy suppliers in the day-ahead spot market have to pay for the capacity regardless of whether it will actually be needed or not. The risk is therefore transformed into one where everyone potentially pays for an event that may not occur and the auction is like a competition over the size of the insurance premium.

It could be interpreted that the missing market leads to common value uncertainty. In a market the value of a contract is found. It depends on the demand and supply conditions in that market and all other markets that are affected by that market. If the market is missing it means that the value of the contract is not determined. In terms of auction theory, there is 'common value uncertainty' regarding the value of the contract.

We have already highlighted that under common value uncertainty, we would expect an open auction to perform better, since in the open auction bidders can adjust their bidding strategy in response to information revealed by other bidders. In a sealed bid reverse English auction, such a possibility does not exist. If the missing market is therefore interpreted as giving rise to common value uncertainty, we would be led to the same recommendation.

5.3.4. Capacity Auctions as a Device for Smoothing out the Cycles of Entry into the Resource Provider Market

Capacity auctions can be viewed as a device for smoothing out the cycles of entry into the resource provider market. The resource provider market has suffered from the problem that many companies file applications for building new plants, but that only a fraction of those plants will end up being built. Not knowing whether a competitor builds a plant makes it harder for rival companies to determine whether they should build or not. If some new capacity can be profitably installed, but not all potential entrants can profitably install capacity, resource providers will have to solve the problem of who enters and who retires capacity.

In an energy market without capacity auctions, or any other coordination device, resource providers would have to invest in capacity not knowing how many other resource providers were simultaneously investing in capacity. A capacity auction acts as a device to facilitate in the following sense: Winners in the capacity auction have an obligation to invest in capacity. This means that resource providers participating in the capacity auction know how much capacity there will be available in the energy market.16 Moreover, resource providers that do not win in the capacity auction know that winners of the capacity auction have already committed to supply capacity, and they can make their investment decisions taking this into account.

Without a centralized auction, a resource provider is uncertain about when another resource providers has hit the "point of no return" in terms of providing its resources in the market. A resource provider has to make guesses about ALL other providers and can make the mistake of assuming a resource is not fully committed when it is, or that it is fully committed when it is not. With the auction, resource providers, when considering winners at the auction, cannot make a mistake, they know they are committed, with a small probability of default.

Example 1: Suppose there are two potential entrants. If both resource providers decide to enter, they will not be able to make a profit in the energy market, as the price will be competed down to a level below break-even. If only one resource provider enters, that resource provider will be able to make a profit of 2 in the energy market. Also, suppose the cost of installing capacity is 1. In this example, profit is –1 if both resource providers enter, profit is 1 if one resource provider enters, and profit is 0 for the resource provider that does not enter. Hence, both resource providers would prefer to enter alone, but if both enter, they would each prefer to stay out, i.e. there is a coordination problem.

If all potential entrants are equally efficient, the coordination problem need not cause too much concern. Any coordination device that will select the right number of entrants will do. On the other hand, if entrants are not equally efficient, the problem becomes one of selecting the right number of entrants ***and*** the most efficient entrants.

5.3.5. The Recommendation of the Descending Clock Auction

As we have illustrated at length, we think that, on balance, the key drivers that we have identified should lead to the adoption of a descending clock auction format.

Multiple round auctions have been used in many electro-magnetic spectrum auctions in telecommunications industries around the world. The Federal Communications Commission (FCC) played a pioneering role in establishing multiple round auctions. In part, the decision context for bidders in those auctions was not dissimilar to the CRAM auction: in both situations,

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[16] Strictly speaking they only know the minimum amount of capacity there will be available since generators that do not win in the capacity auction can still choose to invest in new capacity.

the time horizons are very long, there are differing evaluations as to the value of spectrum and the stakes are relatively large.

Multiple round auctions in energy markets have also recently been used in Canada for the restructuring of the industry Power Purchase Agreement (PPA) and Virtual Power Plant (VPP) auctions. In New Jersey for the procurement of BGS load (since 2002). In France, when as a consequence of the purchase of a stake in German competitor, Electricité de France was forced to divest capacity in a VPP auction. And, most recently, long-term gas capacity auctions in the UK were run with a multiple round format.

We refer to the following sections that are related to the choice of auction format: for aspects of market monitoring and mitigation, section 7, for the variable resource requirement, section 8, for other auction formats, the appendices Appendix A and Appendix B. For abstracts of the relevant auction papers that we consulted for the project, see Appendix C.

5.3.5.1. Competitive properties of the Descending Clock Format

We have emphasized the uncertainty facing bidders (due to the long time horizon of the planning and commitment periods). These reasons also underlie our thinking that the competitive properties of the descending clock auction compare favorably with other formats.

A multi-round auction can be thought of as a bargaining game between different parties. If bidders would want to collude, they would make ‘offers’ to other bidders in the auction. An offer for collusion would usually be the reduction in supply. Bidders in the auction who receive such an ‘offer’ for collusion can then decide to accept it and also reduce their supply, or reject it and to continue bidding at their true supply.

The analogy of multiple round auctions with bargaining tells much about when such a collusive offer game could be expected to be successful:

Simplifying slightly, bargaining tells us that if there are:

- Two parties only;
- Knowledge about bidders′ value estimates and therefore drop-out points;
- Smooth supply schedules, i.e. very small bid decrements.
- A sufficiently high starting price.

Then one could expect that an open auction would result in a collusive high-price outcome. The reason, intuitively, is that (a) both parties know when the game finishes; and (b) both parties can apply 'backward induction' from that point to earlier rounds. The game unravels and the auction stops in the first round. Bidders split total demand.[17]

However, the result is weakened and eventually breaks down when these stringent assumptions are relaxed. When there is uncertainty about where the game ends, then bid decrements and starting prices can be set such that it is not individually advantageous to collude. Even stronger, when the number of bidders increases, then the collusive bargaining game with an early reduction of supply and a high price breaks down. The reason is one of punishment. If everyone is small compared to the total market, then deviation from a collusive bidding agreement only affects prices marginally. Therefore all bidders are given competitive incentives.

We recommend a descending clock auction for its properties of information aggregation and transmission. The same reasons for choosing a descending clock auction, namely the uncertainty as to the value of capacity, also leads us to believe that the simplified result from bargaining of two parties does not apply in our context. We expect the capacity auctions to feature:

- A relatively large number of bidders;
- A lack of knowledge about bidders' value estimate and therefore drop-out points;
- Reasonably lumpy bid decrements, both for reasons of competitiveness as well as plant size.
- A carefully designed starting price.

With these expected features of CRAM, we would expect a clock auction to perform competitively. Moreover, we consider a clock auction to be an important part of the auction design. Given the nature of capacity auctions other auction designs might allow bidders to exploit weaknesses in the auction or result in greater market inefficiencies for other reasons.

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[17] See Ausubel and Schwartz (2000), ***The Ascending Auction Paradox, working paper***

6. DEFICIENCY CHARGES AND OFFER CAPS

6.1. Overview

NERA's assignment includes making specific recommendations on deficiency charges and offer caps. This issue encompasses the need for either or both, the methodology for setting the level and an examination of any desirable interrelationships between deficiency charges and offer caps. Offer caps will be discussed in connection with market monitoring and mitigation. Hence, in this section we discuss the issue of deficiency charges and their interrelationships with offer caps.

6.2. Deficiency Charges

Deficiency charges in the context of the CRAM refer to charges that apply to CRAM supplies that fail to perform. Deficiency charges do not apply to load. Under the CRAM model, load serving entities acquire all capacity from the central market and hence can never be deficient.

Deficiency charges can serve several purposes. These are as follows:

- Provide an incentive to fulfill the obligation beyond that provided by the loss in compensation from capacity payments;
- Provide funds to cover the increased costs that customers and load serving entities may experience as a result of resource inadequacy caused by a failure to perform; and,
- Ensure that bidders do not view the capacity auction as an option as opposed to an obligation to provide and hence, do not propose resources with undue development risks.

In the context of the CRAM, the cost imposed on bidders from deficiency charges must also be considered. Ultimately, it is customers who will bear this cost in the form of higher prices. The objective is to balance this cost with the need for strong assurances. Deficiency charges will affect costs in two ways. First, the risk of incurring deficiency charges will need to be factored into the offer. Second, deficiency charges will need to be secured by credit requirements. Hence, higher deficiency charges will lead to higher credit requirements and higher cost.

With respect to deficiency charges, NERA first examined two alternate directions. The first would be to set deficiency charges based on the equivalent of a mark to market approach, hold suppliers responsible for increased costs that customers may experience as a result of resource inadequacy, adjust deficiency charges to correspond to these potential costs on a forward basis, and implicitly adjust the credit requirements to be sufficient to cover the deficiency charge liability. Under this method, deficiency charges would be unlimited, however, deficiency charges could also be zero or negative, if as a result of default the capacity was replaced at lower costs. This is consistent with trading practices for standard energy products through forward contracts and these provisions have even been incorporated into some longer-term unit power contracts.

Provisions like the above are necessary when the intent is to ensure that the economic bargain agreed to by the parties is actually realized over the term of the agreement even in the case of a default caused by bankruptcy. These provisions are also necessary when the product bought is used as an input to hedge another fixed price transaction. Most importantly, these provisions are necessary in lieu of fixed liquidated damage payments when the defaulting party would have an economic benefit were they to breach and pay liquidated damages. For example, if a seller faced a $25 million liquidated damage payment, but could breach and resell the output of a unit for $50 million increased profit, this approach is required in order to avoid the liquidated damages from becoming simply an option to terminate in order to pursue a better alternative.

The CRAM obligation does not fit into the above model. The CRAM obligation would not be amenable to a mark to market as once the CRAM was implemented there would not be a market for added commitment period capacity. Further, the damages associated with a default would be difficult to quantify. The ISO may not be able to purchase added capacity. Quantifying the damages relative to increasing energy and AS market would be extremely difficult. Even if these values could be established, the potentially unlimited liability on suppliers could reduce their willingness to provide capacity and/or substantially increase costs and prices.

In light of these considerations, NERA does not recommend pursuing this approach.

The second approach we examined was to establish the deficiency charge as a fixed liquidated damage payment. This approach is common in long-term contracts with IPPs that must complete construction. The liquidated damage provision is not unlimited and will not cover the full amount of damages that could result from default. On the other hand, the liquidated damage provision is applicable even if there are no damages. The liquid damage payment is more an incentive to performance than protection against actual damages or an assurance that the economic bargain will be performed. The liquidated damage provision is less risky to bidders as it is not unlimited and can be hedged or insured.

NERA believes that structuring the deficiency payment along the lines of liquidated damages is more suitable to the CRAM obligation. This is the case for the following reasons:

- The unlimited liability of an alternate approach will reduce interest in the auction, increase prices and pose credit difficulties;

- Actual damages or replacement costs will be difficult to determine;
- There is not a clear economic bargain that must be preserved;
- A deficiency charge that provides an incentive for performance along with loss of payments should be a sufficient incentive for performance;
- Qualification requirements will limit speculative offers, and;
- Contractual provisions can be implemented to avoid economic breach because of better opportunities.

NERA recommends that the deficiency payments be structured as follows:

1. A deficiency charge equal to a percent of the auction clearing price – while each ISO may at a different percentage, as a starting point we would recommend between 150% and 100%;

2. The deficiency charge to be stated in $/MW day and if desired, shaped so that it is higher in the summer – say 150% in the summer and 50% in the winter;

3. The deficiency charge for a particular resource limited to a liquidated damage level of between 5% and 10% (these figures are based on what could be obtained in a construction contract) of the total investment cost for new capacity on a per Kw basis – i.e., between approximately $20 per Kw and $60 per Kw; and

4. Deficiency charges be assessed and come due at time that a failure to perform is known or a contract default and termination occurs.

Under this method the following are examples of what could apply. All examples assume a deficiency charge of $200/Mw day for the summer, $50/Mw day for other months and a liquidated damage cap for each facility equal to $50 per Kw or $50,000 per MW.

1. A new unit fails to meet construction milestone six months after signing the contract, the project is abandoned and the project sponsor has failed to acquire substitute capacity. In this case, the deficiency would become due for each day in the contract period, a period of three years. Deficiency charges would not exceed the cap and maximum liquidated damage of $50,000 per MW would be immediately due. For a 500 MW plant, this would be $25,000,000.

2. A new 500 MW unit does not meet in service requirements until July 31 – 61 days into the commitment period and does not procure substantial capacity. The project sponsor

would be liable for 60 days of liquidated damages at $200 per MW day for a deficiency equal to 500 MW thus $200 per MW day times 60 days or $6,000,000.

3. An existing unit is under contract to provide 250 MW, but is able to obtain a UCAP rating of only 240 MW and does not acquire substitute capacity. A charge of 10 MW times $200 per MW or $2,000 will be assessed for each summer day and a charge of 10 MW times $50 per day or $500 will be assessed for each winter day. The total liability on the three-year contract thus would be limited to 250 MW times $50 per Kw or $12,500,000.

The deficiency charge recommendation should keep costs reasonable and in conjunction with other features assure performance. The incentives for performance would be as follows:

- Qualification criteria that ensure a unit is in an acceptable stage of development with respect to siting and permitting (and equivalent measure for demand resources and transmission) or that a plant or demand resource program has an established history;
- Qualification tied to a specific plant at a specific location that is physically verifiable;
- Loss of CRAM payments as a result of failure to deliver;
- Deficiency charges applied daily and shaped seasonally and limited based on a total liquidated damage limit; and,
- Contractual provisions to prevent economic breach to take advantage of situations in which it would be preferable to pay liquidated damages and use the capacity elsewhere.

The above system would incorporate deficiency payments as a reinforcing element in assuring performance as opposed to relying on deficiency payments and financial guarantees as the primary element. This should result in more acceptable price levels. While providing detailed recommendation on contractual provision is outside of NERA′s scope, the following examples are offered to illustrate situations of concern.

- For a unit within any of the ISO′s the contract could require that the ISO has the right to not schedule any transactions that conflict with performance of the CRAM obligation. This would protect the ISOs from the unit operating, but not meeting its CRAM obligation.
- For units outside the ISO, the contract could provide that in addition to liquidated damages the ISOs receive compensation at the prevailing market price where the unit is located if it operates while failing to meet its contractual obligations to the ISOs. This would remove any economic incentive for those units to not perform.

The ISOs would still bear the risk of prolonged outages, plant failures and late or failed development. However, there have always been adequacy risks and are more cost effectively managed through qualification requirements as opposed to deficiency charges.

The ISOs would also bear bankruptcy risks. However, these risks would be limited as the physical capacity would exist, that capacity would just not be committed to the ISO market.

6.3. Interaction Between Deficiency Charges and Offer Cap

No interaction would be required between the deficiency charges and offer cap under NERA's recommendation, as the deficiency charge is an incentive to performance determined separately from the auction price. There is a natural interaction between the auction-clearing price in that the deficiency charge is a penalty on top of not receiving the auction clearing price. A decision would be required on what to do with deficiency payments. The ISOs could rebate those payments to LSEs or could use the funds collected from deficiency payments to fund short-term programs that increase reliability.

7. MARKET MONITORING AND MITIGATION

7.1. Overview

NERA's mandate required that NERA take explicitly into account the impact on study variables of market bidding behavior, and on the ability of participants in the CRAM to game or exercise market power. In arriving at its recommendations on planning horizon, on commitment period, and on the structure of the central auction, NERA consistently targeted choices that would favor competition, would minimize the potential for the exercise of market power, and would minimize gaming opportunities.

NERA, as part of its work scope, was also asked to:

1. Identify any additional mitigation measures that may be necessary to prevent any market participant from exercising market power;
2. Identify any additional measures that may be necessary to prevent any market participant from gaming the rules of the market;
3. Identify any monitoring measures that may be appropriate within the CRAM.

The RAM Group set this task in recognition of the fact that even the most careful market design cannot in and of itself eliminate all opportunities for the exercise of market power or all opportunities for gaming. In a market where there is a limited number of existing market participants, and in which bringing new resources to market is costly, mitigation measures should be considered. These mitigation measures would seek to prevent or to remedy the following outcomes:

- A market participant exercises market power, i.e., it raises the price above competitive levels for a sustained period;
- Markets participants act together and in a coordinated way to raise price above competitive levels for a sustained period;
- Auction participants exploit the auction rules in a way that impedes the objectives of the market.

Mitigation measures would be implemented in specific circumstances when competitive forces fail or are expected to fail to discipline the market outcome. Mitigation measures, if implemented before the auction, can aim to prevent these outcomes; mitigation measure, if implemented after the auction, can aim to identify and rectify these outcomes. We will consider both. Given a sound market design that takes into account market power concerns in each of its aspect, mitigation measures should be expected to be implemented only rarely.

Monitoring, in contrast, should be a routine activity that analyzes and follows the behavior in markets, and seeks to identify any anti-competitive behavior. Anti-competitive behavior comes under the jurisdiction of antitrust laws or under the FERC's enforcement. The RAM Group may nevertheless wish to consider measures explicitly tied to the CRAM that are designed to serve as an additional deterrent for such behavior.

In accomplishing the task of examining which mitigation measures and which monitoring activities may be necessary for the CRAM, NERA proceeded as follows.

1. We reviewed the proposed elements of the CRAM, and identified key elements of the implementation of the market that can enhance competition and reduce the need for mitigation.

2. We identified the specific circumstances in which mitigation measures may be required prospectively – that is, before the auction was held – and proposed measures tailored to these circumstances.

3. We identified the specific circumstances in which mitigation measures may be required retrospectively – that is, after the auction is held – and proposed measures tailored to these circumstances.

4. We considered potential anti-competitive behavior at the auction, identified and analyzed measures that would serve as deterrent to such behavior.

In this section, we present the results of this analysis.

The section is organized as follows. In the first sub-section, we present our general approach to mitigation measures and monitoring, which guided us throughout the analysis. In the process, we review key elements of the market implementation that can reduce the need for mitigation measures. In the second sub-section, we discuss the qualification procedure, and the assessment of qualification that we propose would be carried out by the ISO. It is on the basis of this assessment that the ISO could identify the circumstances in which mitigation measures may be necessary before the auction. We discuss these measures in detail. In the third sub-section, we discuss the circumstances when mitigation measures may be warranted once the auction is complete, and the measures that may then be appropriate. In the final sub-section, we present our proposal regarding the monitoring of bidding strategy.

7.2. General Approach

The first tenet of our general approach to market mitigation is that the burden of achieving competitive outcomes and of promoting competitive behavior should rest – as much as possible

– on the market design itself. This is consistent with the tasks given to us by the RAM Group, which first asked us to develop the elements of the CRAM to maximize the likelihood of competitive outcomes and competitive behavior, and then to suggest additionally mitigation measures that may be necessary. Mitigation measures must be carefully considered and developed, but they must be so developed with the expectation that they will be used exceptionally rather than routinely.

Our recommendations for the planning horizon, the commitment period, the percentage procured, and the recommended auction structure all aimed to provide economic incentives that would promote competition in the market and a competitive outcome.

1. The three-year planning horizon provides a natural competitive discipline to the market. An existing resource will face competition from other existing resources and from all planned resources – resources that will be chosen through the auction and developed, as well as projects that will ultimately not be completed. With a shorter planning horizon, an existing resource will only face competition from other existing resources and from those resources that have committed to development.

2. The three-year commitment period will provide significant revenue assurance for new and planned resources. This revenue assurance should provide economic incentives for new resources to bid more aggressively. The three-year commitment period also provides the possibility of an auction held each year through the implementation of a rolling auction option.

3. A rolling auction option provides to all market participants frequent price signals for adequacy, which should not be unduly influenced by transient market events. Such stable and frequent price signals increase certainty and confidence in market results, which allow market participants and new resources to bid more aggressively. A rolling auction option also eliminates the need for bidders to decide when to bid, in turn avoiding the need for potentially complicated mitigation measures that would need to quantify the price effects of bidders′ deciding when to bid.

4. A descending clock auction is transparent and open. The multiple round process allows bidders to revise their bids during the course of the auction, removing uncertainty and creating economic incentives to bid aggressively. Some strategies that open to bidders to influence price in sealed bid auctions are not available in descending clock auction. The descending clock auction with release of aggregate information is a structure that is resilient to attempts at implicit collusion.

The second tenet of our general approach is that a judicious implementation of the market design can reduce significantly the need for mitigation measures. The implementation should aim to provide bidders with as much information about the economic opportunity afforded by the auction as possible, and should aim to foster confidence in the market. In doing so, bidders face less uncertainty and are more likely to behave competitively. A sound market design, engineered to provide the right economic incentives that would foster competitive behavior, is powerless to deliver on its promise if the rules of the market are unclear, if new resources face insurmountable hurdles to participate, or if the criteria to implement mitigation measures are misunderstood.

Although implementation is not within the scope of this report, we nevertheless wish to emphasize how critical it can be to the success of the market. We also wish to highlight key elements of the market implementation that can most particularly impact participation in the process. By impacting the amount of participation, these elements directly impact the amount of competition at the auction, and thus directly lighten the burden of ensuring a competitive outcome that rests with the market design, and reduce any possible need for mitigation measures. These key elements are:

1. Qualification criteria that are clear and that specifically allow for the participation of planned resources. The ISOs are working at specifying qualification criteria that strike a balance between providing reasonable assurances against non-performance, and minimizing the burden to applicants. Specific criteria that planned but not yet committed resources can meet are essential to harvesting the benefits of a long planning horizon – if the planning horizon is three years but planned resources cannot meet the qualification criteria, the benefits of the planning horizon in terms of providing competitive discipline will not materialize. As mentioned in Section 5.1.1, competition would be fostered by all ISOs adopting similar qualification criteria, since the cost of assessing the economic opportunity afforded by the auction would be lower for new resources.

2. Auction rules that are clear and well understood. The clock auction is easy to understand, and simple bidding strategies can be extremely effective. This auction structure is likely to encourage even less sophisticated potential bidders to participate. The complete auction rules, which will involve several detail design choices and which will be completed in the implementation phase, will need to be articulated well. Sessions to train bidders, as the ISOs do for their other markets, are essential to ensuring that the rules of the market are well understood.

3. The market price is determined in a clear and transparent manner. In a clock auction, bidders and other market observers can see the mechanism by which the prices are determined, through the willingness of providers to offer their resources as prices decrease toward market levels. A clear implementation of the recommended auction structure should provide the transparency needed from the price discovery process.

4. An environment that market participants can expect is stable. If the ISOs show that they are committed to the principles of the CRAM, market participants will place greater certainty in the flow of future revenue from the CRAM and will be willing to compete more aggressively in the market. Conversely, any regulatory uncertainty, or any uncertainty in the long-term viability in the market, will both negatively affect the ability of existing resources to commit to the market and to compete aggressively.

5. The mitigation measures are clear and their scope of application is well understood. Market participants must understand when mitigation measures are likely to be invoked and the range of outcomes and behavior that are considered competitive. Without such certainty, market participants will assess a risk that bids – which the market participants themselves would consider competitive – will nevertheless be assessed to imply the exercise of market power or the use of unproductive gaming.

This discussion of mitigation measures leads us directly to the third tenet of our approach. This tenet is to recognize that the effect that mitigation measures have on market bidding and on the price performance of the market is not just static but dynamic as well. There is a static effect on the market in the sense that when mitigation measures are invoked in some year, they limit the price on the market to a competitive benchmark in that year or limit bids in such a way that this same result is achieved. There is also a dynamic effect. If mitigation measures are used in one year, it may impact how resources providers will bid in other years. Indeed, when resource providers bid in the auction, they consider future revenues from energy and ancillary service markets, and they consider future prices in the CRAM, including the possibility that the price will be mitigated. If mitigation measures depress the price in one auction, resources providers can only be willing bid at higher prices in other auctions in an attempt to earn sufficient compensation in circumstances when mitigation measures are not invoked.

With this general approach in mind, we next examine mitigation measures that can be necessary prospectively, i.e., before the auction is held.

7.3. Prospective Mitigation Measures

Prospective mitigation measures are used before the auction. The ISO assesses that the expected competition at the auction is such that the price cannot be expected to provide an appropriate signal for reliability. Mitigation measures would then ensure that price reflects scarcity in some measure rather than being the product of the exercise of market power.

There are two specific sets of circumstances for which we recommend that the ISOs consider the use of prospective mitigation measures:

1. When there are insufficient resources qualified for the auction to fulfill the requirement set by the ISO;

2. When competition at the auction is expected to be weak and there are no entrants.

We recommend that the ISOs consider triggering these mitigation measures after a careful assessment of the resources that submit qualifications to participate in the auction.

Prospective mitigation measures also include additional auction rules that the ISO can consider implementing as a way to encourage competition in the auction. We propose two such measures that both concern the amount and nature of information that is provided during the auction.

We first present an overview of the elements of the qualification procedure necessary for this assessment. We next proceed to explain further the nature of the circumstances that could lead to the use of mitigation measures as well as a description of the measures themselves. We end by providing our recommendations concerning additional rules for the auction.

7.3.1. Qualification Procedure

Each ISO will decide on qualification criteria and on a qualification procedure. As emphasized earlier, harmonizing the qualification criteria among the ISOs will promote competitiveness at the auction by reducing the cost of assessing the economic opportunity associated with the auction.

We envisage that the qualification procedure will include the following three steps:

1. The ISOs will provide information to prospective bidders in advance of qualification. This information will include a range of starting prices for the auction.

2. Prospective bidders will submit qualification materials to the ISOs, including binding indicative offers.

3. The ISOs will communicate to applicants whether or not they have qualified for the auction. The ISOs will assess the expected strength of the competition at the auction on the basis of the resources that have qualified for the auction.

First Step: Providing a Range of Starting Prices

In outlining the first step of this qualification process, we again emphasize the importance of the market process being transparent to bidders. As much as possible, information that impacts the bidders′ evaluation of the auction opportunity should be communicated to bidders in advance of qualification. This assists bidders in making informed and rational decisions regarding their level of commitment, and regarding their choice of the ISO to which they wish to commit resources. As discussed earlier, this information would include detailed auction rules, clear qualification criteria, as well as the circumstances that would warrant the use of mitigation measures. The information provided to bidders would also include ***a range of starting prices***.

In a descending clock auction, the auction manager proposes prices and suppliers state the amount that they wish to supply at these prices. Prices start high in round 1, and are gradually reduced over the subsequent rounds in response to competitive pressures. The price in round 1 is a ***starting price*** – since, as its name indicates, it is used to start the auction. NERA recommends that the ISO provide bidders with a range of possible starting prices and that the ISO commit to setting the prices in round 1 within this range. In our experience, bidders consider this information critical to their evaluation of the auction opportunity.

To provide a range of starting prices to bidders, the ISO would announce at least two prices: a minimum starting price and a maximum starting price. The price in round 1 of the auction will then be chosen at or above the minimum, and at or below the maximum starting price. Guiding principles to set the maximum and minimum starting prices would include the following:

- The maximum starting price should be set high under the assumption that it would be used when there is no expected risk that the closing price would be close to the round 1 price. It could be used as a round 1 price when competition is vibrant and includes entrants. Competitive forces would then be expected to discipline the outcome. The benefit of setting a high maximum starting price is that it can attract additional participants to the auction; the cost is that if the starting price is set at that level, the auction will take longer to complete as more rounds will be required to get prices to their closing levels.

- The minimum starting price should be set at a level where the ISO would find it acceptable to clear at or near that level. It could be used as a round 1 price when competition is expected to be weak and there are no entrants that can signal the price needed for reliability. We describe this possibility in detail as one of the possible mitigation measures in the next section.

The range of starting prices should be wide enough that the ISOs can reasonably commit never to set the prices in round 1 of the auction outside the bounds it will have pre-defined. However, the range should be narrow enough provide real information to bidders as to the price level at which the auction will start. We will provide additional recommendations regarding the setting of starting prices throughout this section and we will summarize our recommendations at the end.

Second Step: Receiving Applications Including Indicative Offers

The second step of the qualification process is for prospective bidders to submit their applications to participate in the auction. NERA recommends that bidders be required to provide the following as part of their applications:

1. Representations that applicants are acting independently and that there exists no barriers to them competing against all rivals;

2. Indicative offers consisting of the number of MWs that applicants are willing to offer at prices pre-determined by the ISOs, where these indicative offers would be binding in some fashion on the bids in the first round of the auction.

The representations contemplated above would provide some protection against coordinated actions by bidders where these actions could undermine the competitiveness of the auction. Bidders would be required to represent that they are bidding independently (exceptions could be made for smaller bidders as discussed below), that they are not providing information regarding their bidding strategy to rivals, and that they are not using a third party (such as an advisor) as a conduit of information between bidders. If these representations are made but are later found to be false, or if the applicant does not uphold these representations throughout the auction process, NERA would envisage there would be direct consequences to bidders. These consequences would be monetary penalty and/or penalties related to restrictions on the participation of the bidder in future CRAM auctions.

There are three main benefits from requiring such representations. First, the process encourages bidders to be aware of behavior or information revelation that could harm the competitiveness of the auction. For example, bidders can be required to keep information regarding their bidding strategy confidential; merely defining the nature of this information can be valuable in minimizing chances that material information would be disclosed accidentally. Second, it provides an opportunity for smaller or less sophisticated bidders to form alliances and consortia openly, and to declare such associations to the ISOs. These alliances, to the extent that they help smaller bidders participate, are pro-competitive. Lastly, the fact that bidders are required to make these representations can increase the confidence that all bidders have in the fairness and even-handedness of the market.

The indicative offers that applicants would submit with their applications are preliminary bids. In a descending clock auction, a bid is a quantity that the resource provider is willing to commit for the entire commitment period at prices suggested by the auction manager. Similarly, an indicative offer would provide a preliminary quantity that applicants are willing to commit at prices suggested by the ISO. The goal of the ISO is to obtain information from applicants that can be used to decide whether mitigation measures may be necessary. We recommend that the

ISO ask the applicant for a MW-quantity at least two price points within the range of starting prices. One suitable proposal is to ask the applicant for an indicative offer at the maximum starting price, at the administrative price (which will discuss at length later on in this section), and at another price point.

It is envisioned that the ISO will use the information from the indicative offers to form a view regarding the expected competition in the auction. This view would be used to determine whether mitigation measures are necessary. Applicants will know that the information can be used to set parameters for the auction, and this presents a potential gaming opportunity for applicants. An applicant could provide information for purposes of influencing the ISO's decision in a way that the participant perceives to be to its advantage. The information provided to influence the ISO may not truly reflect the economic opportunity faced by the bidders and thus may not be reliable information from the ISO's point of view. To give an example, suppose just for illustration purposes, that the ISO were to ask for indicative offers at the minimum and maximums starting prices, making clear that if the aggregate indicative offers from all applicants at the maximum starting price are high but the aggregate indicative offers at the minimum starting price fall below the requirement, then the ISO will set the price in round 1 at the maximum starting price. If applicants perceive that it is to their advantage for the starting price to be high – maybe because some hope that in the event of weak competition, this will induce closing prices to be high as well – then applicants would then have an incentive to provide inflated indicative offer at the maximum starting price and a zero indicative offer at the minimum starting price. The information provided to the ISO would not necessarily be in line with the applicants' economic opportunities unless other requirements were put in place.

Two elements are necessary to provide applicants with a strong enough incentive to provide information to the ISO that is in keeping with their evaluation of the auction opportunity, and to weaken any incentive to game. First, the maximum indicative offers that applicants are able to make must be justified by the availability of the resources that the ISO will qualify for participation in the auction. This brings the indicative offer in line with an applicant's physically available or planned resources. Second, the indicative offers provided should be backed by financial guarantees and should constrain how the bidder can bid in the first round of the auction. The requirement for a financial guarantee ensures that the indicative offer is not higher than it should be. The requirement that the indicative translate into a bid in the auction makes the indicative offer binding on the bidder at some price. Indeed, a bid in any round of the auction would be binding at the price in effect during the round. This serves as a strong deterrent to providing information that is not in line with the bidder's economic reality.

There are several ways that the indicative offers can be made binding. The ISOs can select the most appropriate procedure depending on the exact nature of the indicative offers and on the type of resources being qualified. The alternatives include:

- Bidders must bid their maximum availability in round 1 if the round 1 price is the maximum starting price.

- Bidders cannot bid more in round 1 of the auction than the indicative offer at the maximum starting price.

- Bidders cannot bid less than the indicative offer at the minimum starting price. (This would be equivalent to requiring applicants to bid if they are qualified).

- If bidders are asked for indicative offers at various price points, once the price in round 1 is set at one of these prices, bidders must bid the indicative offer at the relevant price point.

We believe that the details of how the indicative offer process would unfold is appropriately decided along with other qualification requirements by the ISOs. Our recommendations are mostly directed at the principles that should underlie these requirements given that we propose that the ISOs make decision regarding whether mitigation may be necessary on the basis of information provided by applicants.

Third Step: Assess Expected Competition on the Basis of Qualification

The assessment of the expected competition at the auction would be performed on the basis only of the resources that have qualified to participate in the auction. This can include resources that are both internal to and external to the ISO. This assessment would not consider resources that are known to exist and operate, but that have not applied to qualify for the auction. Indeed, these resources should not be considered, as they will not participate in setting the price for reliability. They should not be considered when evaluating whether mitigation measures may be necessary at the auction.

The assessment of the expected competition, for purposes of deciding whether mitigation may be necessary, would have three goals:

1. Assessing whether there are sufficient resources to fulfill the requirement.

2. Assessing whether new resources are participating.

3. Assessing whether competition is expected to discipline the price.

The assessment whether there are sufficient resources to fulfill the requirement is made on the basis of the indicative offers at the administrative price. The administrative price is an administratively set price that is used when only when resources are nit sufficient to meet the need and it would not be possible to hold a competitive auction. If resources are not sufficient, the auction is cancelled and applicants are provided the administrative price for the amount of their indicative offers. We discuss this option and the nature of the administrative price in the next sub-section.

The assessment of whether new resources are participating is made on the basis of the indicative offers at the maximum starting price. New resources deserve special consideration for their ability to discipline existing resources in the auction and to provide the ISO with the market's evaluation of the cost of entry. All planned resources that require a substantial investment and that can commit capacity to the system should be considered new resources. This would include new generating plans, expansion projects, and the aggregation of demand-side resources. It would not include projects that are put back into circulation after being mothballed or after a period in which they were unavailable, and it would not include increases in availability of new resources unless major investments were required.

The assessment of whether competition is expected to discipline price takes an input the assessment of whether there are new resources participating. If new resources are participating, such new resources are counted on to provide competitive discipline in the auction. If no new resources are participating, indicative offers from existing resources at the maximum starting price and at a lower price point are considered. The determination of whether expected competition is expected to be disciplining would depend on the structure of the market, the size and distribution of the applicants. The following conditions could be used to determine that competition is adequate even if new resources competition did not develop:

- At least 25% of the capacity is bid in by LSEs that have bilateral contracts and that can be expected to bid as price takers.

- Ownership of resources is highly diversified. There is at least modest excess supply at the maximum starting price (in the order of 5% of the requirement, or the amount of the three largest units, whichever is larger).

- Excess supply at the maximum starting price exceeds the capacity offered by the second largest bidder.

Other criteria would be developed by the ISOs on the basis of their particular participants and would be updated from time to time. These criteria would directly take into account the strength of the economic incentives that participants face to provide reliable information, which comes from the precise manner in which indicative offers are binding. If there are known biases in reporting the information, the assessment would be adjusted to take into account these biases.

We now turn to the mitigation measures envisaged.

7.3.2. Resources Are Not Sufficient to Fulfill the Requirement

Given a three-year planning horizon, given qualification requirements that would be tailored to the participation of planned resources, and given best efforts to provide information about the auction opportunity to bidders, the possibility that resources would not be sufficient to fulfill the requirement is at best remote. Nevertheless, the contingency must be considered and a plan devised, so that the ISO is ready in case it does occur, and so the bidders can take it into account when evaluating their future revenue expectations from the market.

If resources are not sufficient to fulfill the requirement, the auction must be cancelled and the ISO must determine the price to be received by resource providers administratively[18]. Resource providers that applied to participate in the auction would be paid the administrative price for the amount of their indicative offer at the administrative price.

There are two questions that must be answered to provide a complete picture of how to plan for this contingency:

1. How will the administrative price be set?

2. Are there any complementary measures that could be used to promote reliability?

The setting of the administrative price must balance two objectives. First, the price should be set high enough that it provides a meaningful economic signal, related to the fact that there is a shortage of qualified resources. The administrative price should not discourage future entry. Second, the price should not be set so high that it is perceived by resource providers to be an upside opportunity that can compensate them for potential periods of depressed revenues. Resource providers should not be encouraged to withhold from the qualification process in order to bring about the administrative price. In part, resource providers should be confident that the CRAM auction, when entrants participate, will yield a price that is not mitigated and will provide compensation for entry costs.

NERA proposes that the administrative price be set at the cost of a new CT amortized over fifteen years. There would be no offset for energy or ancillary service revenues. NERA believes that this price provides a good balance between the two objectives stated above. The price should be high enough not to discourage future entry, and yet it should not be so high that it

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[18] There is no point holding the auction as it would end in the first round at the price established by the ISO, which would also in essence be administratively determined.

becomes an incentive for resource providers not to qualify resources into the auction. This methodology should be well understood by resources providers who can then use it readily in forming their expectation of future capacity market revenues. The administrative price should also be able to garner customer acceptance as this method has been used in the past to set deficiency charges.

The ISO should also consider two additional measures if resources are insufficient in a given auction. First, NERA recommends that the period during which the administrative price is received be limited to one year and that the remaining portion of the commitment period be procured in the following auction. That is, if in the 2005 auction resources are insufficient to hold an auction for the commitment period June 1, 2008 to May 31, 2011, then resource providers that have applied for the auction get the administrative price for the amount of their indicative offer at the administrative price for the period June 1, 2008 to May 31, 2009. In the 2006 auction, resources providers would be able to bid to commit their resources from June 1, 2009 to May 31, 2011, or from June 1, 2009 to May 31, 2012. Second, depending on the size of the shortfall, the ISO could consider procuring additional demand response resources. These resources could be procured closer to the beginning of the supply period. The administrative price is not a price cap and would not limit price in a competitive auction.

7.3.3. Expected Competition is Weak and There Are No Entrants

NERA would expect that the circumstances in which competition at the auction is expected to be weak (which, as described above, would be defined given the ISO′s particular market structure and the characteristics of its resource providers) and in which no new resources have qualified will be the exception rather than the rule. These circumstances must nevertheless be considered ahead of time and must be considered with care. The risk associated with this situation is that the competition at the auction will not sufficient to discipline the price. The auction would then end after very few rounds, at prices that would be reasonably close to the price in round 1. To the extent that the level of these closing prices would not mainly reflect the scarcity of capacity resources, the ISO may decide that mitigation measures are appropriate. NERA believes that the mitigation measure that the ISO should consider is the setting of a ***reserve price***.

A reserve price is defined by two key elements: it is a price set as the price in round 1 of the auction, and it is a price that the ISO would find acceptable even if it were as the closing price of the auction. This means that after setting a reserve price, even if competition at the auction is indeed weak and the auction closes after very few rounds, the end result will acceptable, as the closing price is lower but in general close to the reserve price level. The ISO would consider the reserve price level an acceptable closing price given the level of scarcity in the market and the potential future need for capacity. Given that the reserve price is a price set in round 1, it must be a value that is between the minimum and the maximum starting prices set by the ISO before the qualification process.

The ISO may choose to use this mitigation measure, or may choose to proceed with the auction if it has a reasonable expectation that competition, although weak, is still sufficient to discipline the price. If the ISO proceeds with the mitigation measure, the ISO must communicate to entrants that the price in round 1 of the auction is a reserve price.

The advantage of proceeding with the mitigation measure is that it provides prospective bidders with a reasonable amount of certainty. Bidders will know that the result of the auction, whatever the actual level of competition happens to be, will be acceptable to the ISO. This provides bidders more certainty compared to a situation where the ISO does not set a reserve price, proceeds with the auction, finds the result unacceptable and mitigates the price after the auction. The disadvantages of proceeding with the mitigation measure is that if the ISO has misjudged the level of competition and it is stronger than expected, the resulting price may not be an appropriate signal for reliability and may discourage future entry.

The level of the reserve price should reflect an acceptable long run price. NERA proposed two alternative methods to set the reserve price. The first method is to use an estimate of the price that would be set if entrants were participating in the auction. The second method is to emulate the economic incentives that would lead to entry even without a capacity market.

First Method: Entrant-Based Price

As mentioned above, if new resources are participating in the auction, NERA expects that these new resources will discipline the price in general. The concept behind an entrant-based reserve price is that it is always an acceptable signal for reliability, even if a particular auction has not attracted new resources. Calculating an entrant-based price would require an estimate of what new resources would bid in a particular auction. This would require an estimate of:

- the investment cost of the new resources;
- expectations of energy and ancillary service market revenues;
- expectations on the result of future CRAM auctions and on the future use of mitigation measures;
- evaluation of risks going forward;
- assumption regarding the appropriate amortization period for entrants;

- evaluation of the evolving structure of the market and of the competition on all markets going forward.

We believe that this estimate cannot be done with any degree of accuracy, most importantly because there is no reasonable way to make an assumption regarding the appropriate amortization period. Ultimately, it is a function of the competitive market to reveal what this appropriate amortization period is. The uncertainty with respect to amortization arises because the CRAM provides only a three-year commitment period, and the long-term risk of future capacity market opportunities is inherently uncertain. For this reason, NERA recommends initially using the administrative price as a reserve price. Once experience is gained with the CRAM, and that the results of competitive auctions that involve new resources can be analyzed, the reserve could be revised to provide a better estimate of an entrant-based price.

Second Method: Emulate Economic Incentives Needed for Entry

The concept behind the second method goes back to the role of the capacity market. The capacity should provide meaningful economic signals to ensure reliability. In particular, the capacity market should provide a price signal that induces entry when it is needed.

If there were no capacity market, basically all economic signals, including any signals for entry, would come from the energy market. The normal dynamic of competitive markets would apply. Positive economic profit would induce entry, economic losses would signal the need for exit, and zero economic profit for the marginal firm would prevail in the long run equilibrium. For these dynamics to operate in the energy market given the uncertainty in energy market revenues, the economic profit expected may need to be substantial before resource providers would be induced to commit new resources. Once entry took place, supply would expand and this would gradually return the market to a long run equilibrium in which economic profit is zero[19].

The cost of counting on the dynamics of the energy market to induce entry is that entry may be late and reliability may suffer. The advantage of having a carefully designed capacity market instead is that the signal for entry can come before the commitment period – in our proposal, the price signal for adequacy can be provided three years before resources are actually needed. The fact that this economic incentive will be provided ahead and will be provided with certainty means that a lower price and lower economic profit would be needed to induce the same level of entry. Given that the capacity market in essence replaces the economic incentive that would be provided by a competitive energy market, it should emulate the economic incentive that the energy market would have provided.

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[19] These basic economic dynamics are illustrated in Appendix D.

The entry-incentive approach starts with a reasonable estimate of the economic incentive that an unmitigated energy market would have given for new resources to enter. This estimate would involve:

- estimating the long-run recovery of fixed cost and return on investment;
- estimating the opportunity cost of resources including the cost of energy market mitigation.

Before experience is gained with the market, NERA would recommend that, in keeping with the first method, this estimate be constructed using the administrative price, allowing for economic profit and for the opportunity cost of mitigation measures in the energy market. The entry-incentive approach would then recognize that the need for new resources is not black and white. There is a probability, but a probability only, that entry will actually be needed. A probability adjustment would be constructed on the basis of the probability that load would be in fact greater than the normal forecast. The reserve price would be obtained by taking the expected required economic incentive, i.e., multiplying the estimate of the economic incentive by the probability adjustment. The lowest possible reserve price calculated in this manner would be constrained to be no lower than the going-forward cost of the most expensive resource.

An example is provided below.

<table>
<tr><th colspan="3">Target Reserve 18%
Entry-based reserve is $75/kw Year
Adjusted entry-based reserve to allow for economic profit is $90/kw Year</th></tr>
<tr><th>Reserve Provided by Qualified Capacity</th><th>Probability Adjustment</th><th>Reserve Price</th></tr>
<tr><td>- % -</td><td>- % -</td><td>$/kw Year</td></tr>
<tr><td>23 and greater</td><td>30%</td><td>30</td></tr>
<tr><td>22</td><td>45%</td><td>40.5</td></tr>
<tr><td>21</td><td>65%</td><td>59.5</td></tr>
<tr><td>20</td><td>79%</td><td>71.1</td></tr>
<tr><td>19</td><td>97%</td><td>87.3</td></tr>
</table>

Comparing the Methods for Setting a Reserve Price

The entrant-based method, save for updates due to auction experience, provides the same reserve price regardless of the circumstances. The advantage of this method is in promoting the reliability and the stability of the auction results. Bidders will perceive that there is an increased certainty in their estimate of future capacity revenues.

The entry-incentive method takes explicitly into account the probability that entry is needed. The advantage of this method is that it adapts the reserve price to the particular competitive conditions that prevail in the market at the time and may provide a more targeted signal for reliability.

NERA believes that both methods could be used and if consistently apply could fulfill the objectives of the ISOs.

The reserve price would not be a price cap in auctions where there were adequate competitors.

7.3.4. Persistent Circumstances

NERA's recommendations rely on the assumptions that supply in the ISO is workably competitive so that appropriate choices for the planning horizon, commitment period and auction format can induce entry, and so that the appropriate price for adequacy can be competitively set by the market through an auction. NERA believes that these assumptions are appropriate to the study and to the general recommendations that we have put forward. However, we do recognize that at the present time, the NYISO and ISO New England both have sub-markets where competition among existing resources is weak and in which this weak level of competition has been sustained over the medium term. NERA has not performed a thorough competitive assessment of each potential sub-market for the ISO. NERA recommends that, following such an assessment, the ISO consider carefully the application of additional mitigation measures situation for any sub-market where competition from existing resources is expected to be limited and is expected to continue being limited over the long or the medium term because of local barriers to entry. Such a sub-market would be characterized by the following elements:

- A small number of competitors in a particular local market;
- Severely restricted competition from resource providers outside the region;
- Entry cost that are higher than in adjoining regions;
- Regulatory impediments to entry or circumstances that prevent price from rising sufficiently to provide adequate incentive for entry.

In these circumstances, the ISO would have to determine whether the market is workably competitive and whether an open auction can be used. The behavior of market participants would be monitored, a topic to which we return in Section 7.5. If the ISO decides that competition is sufficient for an open auction to be used, NERA would recommend that the ISO consider the application of an alternative mitigation measure. This mitigation measure targets the possibility of coordination by existing resource providers and weakens the incentives to do so. This measure would be used in place of a reserve price, which is meant to address circumstances in which, as an exceptional case, the qualified resources are not expected to discipline the price and there is no entrant.

In general terms, if there is a small excess supply in the market, and if there is a small group of existing resource providers, then a strategy exists for bidders to coordinate on a high price outcome. Each resource provider can withdraw a small quantity; taken together, the quantity withdrawn by all bidders is sufficient to close the auction, i.e., it is sufficient for the quantity offered to match the quantity needed. If these reductions are coordinated and occur sufficiently early in the auction, a high price outcome results. The benefit for each resource provider of this strategy is the higher price obtained for the capacity offered; the cost for each resource provider is the reduction in quantity offered.

If each can withdraw a small amount in order to achieve the high price outcome, this strategy makes all resource providers winners. Resource providers should find it easier to coordinate in this manner if they all have roughly the same market share, so that they can naturally all reduce by roughly the same quantity, and share equally in the benefits and the costs of the strategy. If such a possibility is a concern to the ISO, NERA suggests a restriction on bids that weakens the incentive to coordinate by eliminating the possibility that all resource providers are winners. The recommended restriction is to put a floor on the amount that a bidder can withdraw. This floor would be set in such a way that one bidder could not close the auction with one reduction – that is, the floor on the withdrawal would be less than the initial excess supply. However, a second bidder reducing its quantity bid could close the auction but would be afforded the opportunity to withdraw only a portion of the floor quantity.

For example, suppose that there are three bidders participating in the auction and the excess supply is 600 MW. With no bid restrictions, each bidder could withdraw 200 MW, close the auction and obtain a higher price for the committed quantity. Now suppose that there is a floor on a reduction of 500 MW. To close the auction, the first resource provider to reduce its quantity bid would need to withdraw 500 MW, the second resource provider to reduce its quantity bid would also need to withdraw 500 MW. For the second resource provider, 400 MW could be retained to fill the requirement. There are now winners and losers. The third resource provider that did not reduce its quantity bid free rides significantly on the reductions by the first two resource providers. The incentives are now set so that resource providers will want to compete to be the one that does not reduce its quantity bid and that does obtain a price for the entire quantity that they can commit to the market[20].

To use such a restriction on bids, the ISO would need good information on the excess supply in the market and on the characteristics of the resource providers participating in the auction. The floor on the amount to withdraw must be sufficient to be a deterrent for coordination, but not so high that a single participant can close the auction single-handedly. The analysis to be conducted to set such a floor could be significant. Therefore, such a restriction on bids is particularly indicated when the ISO expects that the circumstances leading to weak competition in a given market are likely to persist into the medium or long term.

7.3.5. Additional Auction Rules

One of the strengths of the auction format that NERA recommends is that bidders obtain information as the auction progresses and can revise their bids on that basis. However, it is possible to have too much of a good thing. For example, with very precise information about the amount of excess supply left in the auction, a single bidder could reduce its amount bid by just enough to close the auction. In general, a balance must be struck between the benefits of providing information to bidders so that they can learn as the auction progresses, and providing so much information that it enables bidders to use anti-competitive strategies.

NERA recommends two restrictions on the information provided to bidders during rounds.

1. Information provided to bidders in each round should be aggregate information; no bidder-specific information should be reported.

2. Information provided to bidders should be less precise as the auction draws to a close.

Bidders benefit by having access to aggregate information, such as the prices that will be in force in the next round and an indication of the total excess supply at the auction at these prices. A bidder learns from knowing that other bidders are not reducing their amount bid as the price is reduced over rounds. The bidder may well revise its anticipated price points on that basis. Arguably, a bidder could learn even more by knowing that a particular bidder with a particular portfolio has maintained its quantity bid as the price is reduced. However, bidder-specific information can also be used anti-competitively. Bidders who have agreed to coordinate their bidding strategies can use bidder-specific information to monitor whether the agreement had been followed. Incumbents could also use bidder-specific information to ensure that their bids

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[20] The situation presented here is formally equivalent to a war of attrition, which has been analyzed extensively in the game theory literature. See ##add references.

are effective in deterring new players from entering the market. NERA believes that any benefits from providing bidder-specific information are outweighed by the cost of facilitating certain anti-competitive strategies. NERA therefore recommends that only aggregate information be provided to bidders.

This aggregate information to bidders would include an indication of the excess supply remaining in the auction. For example, bidders could be provided with a range for the remaining excess supply. If the excess supply were 1415 MW in a given round, bidders could be told that the excess was in a range between 1400 MW and 1450 MW, without being told the exact amount of the excess supply. The narrower is this range, the easier it is for bidders to evaluate the reduction in the amount bid that is just sufficient to close the auction. For this reason, NERA recommends that the information regarding the amount of excess supply be made less precise as the auction draws to a close, so that bidders cannot unilaterally reduce supply in an amount just sufficient to close the auction.

7.3.6. There Is No Mitigation Where Competition Is Adequate

If the CRAM is to attract entry and assure capacity adequacy and if the CRAM is to reveal the market price for adequacy, there must be conditions under which mitigation and the setting of an administrative price will not prevail. As long as there is competition among new resources, NERA recommends that this competition be permitted to set the price and that no mitigation be employed. While this section is largely devoted to a discussion of when mitigation would occur and what mitigation would be employed, in most cases, there would be no mitigation and price would not be set or capped administratively.

Rather, entrants would offer new resources and compete to win capacity market contracts for those resources. We would expect that forming offers, competition would consider their costs, expected energy and AS net revenues and expectations of future capacity market opportunities. They could then determine the price in the current auction needed to induce entry.

It is important that this price not be mitigated or limited administratively. Resource owners will face many long-term risks. Among them are the risk that in future capacity auctions there will be surplus and prices will be low, that future capacity auctions will have insufficient participation and close at the administrative price, and that future capacity auctions could have limited competition and face a reserve price. These risks and offers will need to be reflected in offers.

As a practical matter, this means that after the fact, the price for a competitive auction from a new resource may be substantially higher than that implied by a twenty-year amortization of capital costs less net energy revenues. The upper limit would be an amortization over the commitment period, less net energy revenues. However, in all likelihood, competition will reveal where in between, entrants require price in order to induce entry consistent with the risks posed by the commitment period. The CRAM can only reveal this competitive price if it operated without mitigation when there is sufficient competition.

The price when there is sufficient competition, and competition among entrants, may well be higher than the administrative price and higher than the reserve price. At first, this may seem counter intuitive as one would expect higher prices when resources are scarce and there are less competitors.

It is however, precisely because there is insufficient competition that mitigation is needed and when mitigation is needed, price levels must be perceived as reasonable and not encourage withholding from the auction qualification process. Well-articulated mitigation methods can then be used by bidders when evaluating and developing competitive offers.

7.4. Retrospective Mitigation Measures

Retrospective mitigation measures are applied, if necessary, after the auction.

Retrospective mitigation measures are never used when prospective mitigation measures have already been invoked. That is, retrospective mitigation measures are never used when:

1. There are insufficient resources qualified for the auction to fulfill the requirement set by the ISO and the ISO invokes the administrative price;

2. The competition at the auction is expected to be weak, there are no entrants, and the ISO chooses to invoke a reserve price.

When the ISO has set a reserve price, the ISO has already acted to mitigate the price in line with an acceptable signal for adequacy. The reserve price is, by the way it is set, an acceptable price level, so no further measures should be invoked. In addition, NERA recommends that retrospective mitigation measures not be used when new resources participate in the auction and contribute to setting the price. The auction is designed to elicit market information regarding the cost of entry; the auction accomplishes this objective when competitive pressures from new resources establish the closing price. In these circumstances, the closing price in these circumstances should provide a reliable signal for adequacy.

In circumstances other than the ones mentioned above, the ISO is expecting that competition was sufficient to discipline on the basis of its assessment of qualifications for the auction. The expectation will likely be realized as long as the resources that have applied for the auction place bids, especially any new resources that have qualified. However, it is always possible that competition that was reasonably expected at the qualification does not in fact materialize. For example, new resources that were expected to compete in the auction may encounter unexpected problems with the development of their project, and may withdraw.

When the competition that was expected at the auction does not materialize, NERA recommends that the ISO compare the closing auction prices to a competitive benchmark. By materialize, we do not mean to judge the result, but to observe that resources, which have qualified, fail to bid. If the auction prices compare favorably to the competitive benchmark, no further mitigation measures would be invoked. If the result does not compare favorably to the competitive benchmark, if there is clear evidence of market power, as the auction price does not appear to a consequence of scarcity, then NERA recommends that the ISO consider invoking retrospective mitigation measures. These measures include re-running the auction and/or limiting the price that resource providers obtain during the commitment period.

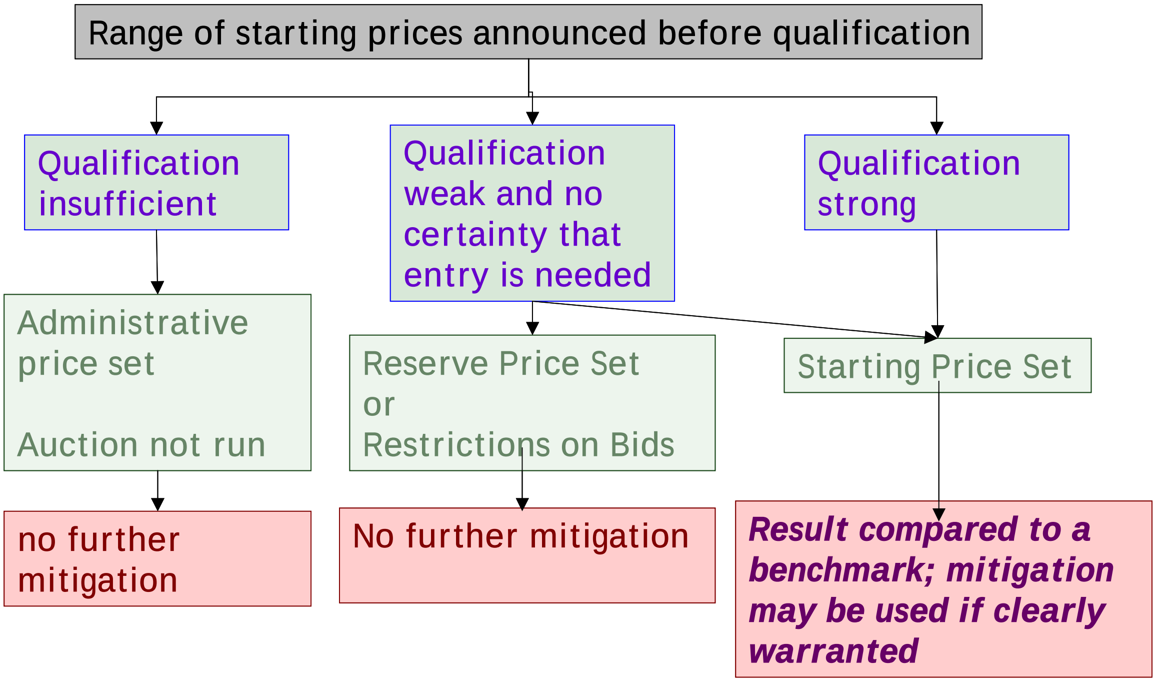
In the subsections that follow, we will outline:

1. Alternative methods to construct a competitive benchmark to which the ISO compares the auction price when the expected competition did not materialize;

2. Mitigation measures that the ISO can consider if the final auction price does not compare favorably to the competitive benchmark.

A chart that summarizes the circumstances in which retrospective mitigation measures would be considered is provided below.

Figure 7-1.
When Mitigation May Be Used



7.4.1. Competitive Benchmark Alternatives

A competitive benchmark is a standard against which the auction price is compared. The competitive benchmark should be an estimate of a capacity price that would provide an adequate signal for reliability and that would be expected to result from the competitive behavior of resource providers. If the closing auction price compares favorably to the competitive benchmark – by which we mean that the auction price is equal or within reasonable bounds of the competitive benchmark – then NERA assumes that the result will be acceptable to the ISO.

NERA will suggest three methods by which a competitive benchmark can be constructed. One of these methods bases the competitive benchmark on the going-forward costs of existing resources. The other two methods, an entrant-based price and the entry-incentive approach, echo our approaches to estimating the reserve price as presented in Section 7.3.3.

This is not a coincidence. When estimating the reserve price as a prospective mitigation measure, the objective is to establish a price that would be acceptable to the ISO as a signal for reliability when competition is expected to be weak. When constructing a competitive benchmark as a retrospective measure, the objective is to establish a price that would be acceptable to the ISO as a signal for reliability when competition is weak (even though competition was initially expected to be more robust). The objective in both cases is basically the same. The only difference is timing: for the reserve price the calculation is performed before the auction since the mitigation measure is to be applied prospectively, while for the competitive benchmark the comparison is performed after the auction since the mitigation measures is to be applied retrospectively.

We briefly summarize the two methods that were first explained in Section 7.3.3. We then proceed to present a third method based on going-forward costs.

First Method: Entrant-Based Price

The first method is to calculate an entrant-based price. This method is based on the idea that an entrant-based price is an acceptable signal for reliability, even if a particular auction has not attracted new resources. Conceptually, an entrant-based price would require an estimate of what new resources would bid in a particular auction. Practically, NERA believes that this cannot be estimated reliably and therefore recommends that the ISO initially use the administrative price as an entrant-based price. The administrative price is the cost of a new CT, amortized over fifteen years with no offset for energy or ancillary service market profits. The ISO would revise this entrant-based price on the basis of experience with the CRAM, using the results of competitive auctions in which new resources have participated. The main advantages of this method is the stability of the price expectation set by the ISO, and the fact that the price should serve as an adequate signal for reliability.

Second Method: Entry-Incentive Approach

The second method is to estimate the economic profits that would have been required to induce entry in an unmitigated energy-only market. The goal of the CRAM is to provide the price signal for adequacy instead of counting on energy market dynamics to do so. The idea behind this method is that the price is an acceptable signal for reliability if it emulates the economic incentive for entry that would have been provided by a competitive energy market.

Conceptually, the entry-incentive approach requires two elements: a reasonable estimate of the economic incentive that an unmitigated energy market would have given for new resources to enter, and a probability that entry is necessary. Practically, NERA recommends initially using the administrative price, allowing for economic profit and for the opportunity cost of mitigation measures in the energy market, as the estimate of the economic incentives. NERA also recommends constructing a probability adjustment on the basis of the probability that load would be in fact greater than the normal forecast. The competitive benchmark would be obtained by multiplying the estimate of the economic incentive by the probability adjustment.

The competitive benchmark would be constrained not to be below the going-forward cost of the more expensive resource.

The advantages of this method are that it can be sensitive to the state of competition for a particular auction, and that the price signal reflects more closely the potential need for additional resources.

Third Method: Using Going-Forward Costs

The third method is to calculate a competitive benchmark on the basis of going-forward cost of existing resources. The concept behind this method is that existing resources should be in the auction as a function of their going-forward cost. As price is reduced through the rounds of the descending clock auction, the highest cost providers would exit the auction first, leaving the lower-cost providers. The price of a competitive auction should then be in line with the lower going forward cost of providers that have reduced the amount of resources they wish to commit. New resources are excluded since in an auction where new resources are competing, there would not be prior sales mitigation and there is no role for the competition benchmark.

The method would first estimate the going-forward costs for existing units in the ISO. All non-sunk costs would be considered as going-forward costs and would be used in the estimation of this competitive benchmark. These non-sunk costs would include:

- Property taxes;
- Operation and maintenance costs;
- Costs of capital additions;
- Insurance;
- Environmental compliance costs;
- Overhead and costs of continuing to use site for existing units;
- Expected energy and AS net revenue.

The non-sunk costs would be estimated on a unit-by-unit basis.

The method would then focus on the going-forward costs of the units of resource providers that have reduced their amount bid in the auction. We would assume that if a resource provider has reduced the amount bid at the auction, this quantity is being reduced first from the unit with the higher going-forward cost, then as necessary from the unit with the next higher going-forward cost, etc. The method would identify a group of units whose capacity was withdrawn from the auction. The competitive benchmark would then be set at the lowest going-forward cost of the units that were identified in this manner.

The advantage of this method is that it considers the cost of existing resources, and that in particular the higher cost of inflexible, older capacity will be taken directly into account. The disadvantages of this method are two-fold. First, this method requires detailed information on individual units while other methods for computing the competitive benchmark require only more general market information. The ISO will have to request unit-specific information from bidders for the purposes of these calculations. These information requirements will have to be made clear to participating resource providers. Second, in smaller markets, this method could yield an inappropriate price signal. If entry occurs in this type of market, a surplus may result that would be sustained for a few years. If no older units are required to fill the ISO's requirement, the competitive benchmark may be set at a level that is inappropriately low, and that does not provide a meaningful signal for adequacy.

7.4.2. Possible Mitigation Measures

Only circumstances in which, on the basis of the qualification process, the ISO is expecting that competition will discipline the price, but that this competition does not in fact materialize, NERA recommends that the ISO compare the closing auction price to the competitive benchmark computed according to one of the methods described above.

If the price compares favorably, i.e., the price is at or below the competitive benchmark, then the ISO would take no further action. Given that each method establishes an estimate of the competitive benchmark, the ISO could also consider establishing a safety band around the competitive benchmark level and consider the auction price to be acceptable as long as it is within that band.

If the price is above the competitive benchmark, NERA recommends a three-step approach.

1. The ISO examines why competition that was reasonably expected at the auction did not in fact materialize. If additional competition is expected within three months, the ISO re-runs the auction.

2. If no additional competition is expected within three months, the ISO considers whether developments in the market or experience with previous auction indicate that the competitive benchmark was set too low. If the ISO finds that there are developments in the market that explain the auction results, the ISO takes no further action.

3. If no additional competition is expected within three months, and if there are no market developments that imply that a revision of the competitive benchmark is indicated, then the ISO sets the capacity price at the level of the competitive benchmark.

We explain the approach in more detail below.

First Step: Consider Possibility of Auction Re-Run

NERA envisions that the auction would be run perhaps in January or February, three years ahead of the start of the commitment period that starts in June. There would be time to re-run the auction and still procure the requirement with a three-year lead-time.

The ISO would consider the possibility of an auction re-run if:

- Resources that had qualified for the auction had not been able to participate to the extent anticipated; and

- If the auction was re-run within a short period, competition at the auction was expected to increase meaningfully.

NERA would recommend the following guidelines if the ISO decides to re-run the auction. First, to enhance participation, the ISO should promote this second opportunity widely. All market participants, and in particular new resources that had been expected to participate in the first auction but had not, should know that there is a second opportunity to commit resources for the commitment period. Second, given the passage of time and given the information that the first auction will have generated, resource providers should be allowed to update their indicative offers or any other time-sensitive information submitted during qualification. Resource providers that had qualified in the first auction would be invited to qualify for the second auction as well, and additional resources would be able to qualify as well. Third, NERA would recommend setting the starting price at a level no lower than the original auction starting price so as to preserve the level of participation at the auction. Finally, the ISO should consider doing the auction re-run within three months of the original auction. This period of time should be long enough to enable new resources that had unexpectedly been unable to participate to resolve any problems, but it should be short enough not to introduce uncertainty about the price that will prevail during the commitment period, or about whether the auction will be run at all.

Second Step: Consider Whether Revisions to the Competitive Benchmark are Indicated

If there is no reason to believe that the pool of qualified resources or the participation at the auction would change within three months, then the ISO will not consider re-running the auction. The ISO would further assess the auction results. In circumstances where there is sufficient participation and no reason to believe that there were bidding irregularities, auction results will reflect the judgment of the market regarding future expectations of revenues in the energy and ancillary service markets, as well as expectations of future capacity auction. The ISO can accept this judgment of the market, even if the closing auction price is higher than would be indicated by the competitive benchmark.

The ISO should be more willing to proceed in this manner when recent developments in the market, or recent experience with auction results support the judgment of the market. For example, recent developments in the market may indicate that prospects for future revenues in the energy or ancillary serves have decreased, or recent auctions in which new resources had participated may indicate that the amortization period used by the market is shorter than had been presumed. If the ISO does accept the auction results, the ISO will then incorporate this judgment of the market into the future setting of the competitive benchmark.

Third Step: Mitigate the Price Using the Competitive Benchmark

The ISO would mitigate the auction price using the competitive benchmark as a last resort. The ISO would take this measure in circumstances where:

- No new resources had participated in the auction;
- The auction price was above the competitive benchmark or a reasonable band above the competitive benchmark;
- The ISO found no reason to believe that the pool of qualified resources or the participation at the auction would change if the auction were re-run within three months;
- The ISO found no rational basis for the auction results to exceed the competitive benchmark taking into account developments in the market or previous auction results.

Resource providers would receive a price equal to the competitive benchmark. A resource provider could elect to receive this price for the last quantity that the resource provider bid in the auction. However, given that the competitive benchmark is lower than the closing price, resource provider could also elect to receive this price for a lesser quantity, if the resource provider had provided a lesser quantity in its indicative offer for a similar price. The ISO may need to run an additional procurement for any gaps, as discussed in Section 12.3.

7.4.3. Special Circumstances

The auction format should provide the capacity requirement at the lowest price consistent with market conditions. We have examined carefully in the previous sections actions that the ISO would consider if the auction does not fulfill this mandate, in the sense that price exceeds expectations as set by the competitive benchmark.

NERA recognizes that the ISO could also be legitimately concerned by situations in which the price was too low to effect entry. The situation would be one in which potential entrants are competing with incumbents, and incumbents drive the closing price low enough to deter entry. To the extent that this situation materializes because incumbents have employed a deliberate strategy to keep entrants out, the ISO could identify this situation by monitoring bidding behavior. We discuss this possibility in the next section.

7.5. Monitoring

NERA assumes that the ISO will routinely monitor bidding at the auction, regardless of the outcome and regardless of whether any mitigation measures are being considered. NERA also assumes that that the ISO would take as its base assumption that bidding is competitive unless the round-by-round results of the auction clearly indicated otherwise. The ISO would, through these monitoring activities, aim to detect any bidding irregularities, and would center its monitoring around three questions:

1. Is there evidence of coordinated behavior?

2. Is there evidence that incumbents have attempted to deter entry?

3. Is there evidence of the unilateral exercise of market power?

Evidence of coordinated bidding behavior would require patterns of behavior where bidders have acted in concert to establish a closing price in the auction that is higher than it would have been otherwise. Possible evidence includes a pattern where bidders mirror each other's bidding strategy; for example, bidders could be consistently reducing the amount bid in the same or in succeeding rounds, and/or submitting identical exit prices that are close or equal to the previous round price. Other possible evidence, in an auction with several products that are substitutes, is for bidders to avoid competing with each other and to choose different product on which to bid.

It is possible that incumbents (i.e., market players that have an existing portfolio of resources) find it to their advantage to deter new entrants (i.e., new entities that bring additional resources to the market). The deterrence of entry could occur through the auction. Incumbents would have both to bid in themselves new resources that can fill the requirement, and to compete the capacity price down to a level that is unacceptable to a new entrant. This strategy lowers the capacity price but it ensures that a new player does not enter the market. The strategy can be profitable if it raises the expected energy market revenues (because there are fewer market players) by an amount that is sufficient to compensate for the low capacity price.

To put this strategy into effect when new resources are in fact needed by the market, an incumbent would have to plan new resources that it would bid in the auction, but that it would ultimately not plan to develop fully. Evidence of incumbents attempting to deter entry would then require at least all of the following:

- Incumbents continue bidding their maximum quantity in the auction until entrants have exited the auction, and then incumbents reduce their quantities bid to close the auction;
- Incumbents have added new resources to their portfolio, and these new resources have qualified for the auction;
- Incumbents do not bring the anticipated new resources to market, either defaulting on their commitment or contracting to fill their commitments through the reconfiguration auction.

The unilateral exercise of market power is typically difficult to discern. It must be expected that bidders attempt to maximize profits when bidding in the central auction. We expect bids to be related to cost, but bids are not a straightforward function of these costs, as they would necessarily take into account future revenue expectations, future market structure and expectations of future revenues from the central auction. Evidence of the unilateral exercise of market power would need to include bidding pattern that show that an existing resource provider has attempted or succeeded in closing the auction at a price that is above the competitive benchmark. (The analysis will follow more straightforwardly from the mitigation approach if the competitive benchmark is established on the basis of going-forward cost.) It is likely that this kind of strategy would only to be possible for existing resource provider that have an important existing portfolio, and that have good information about the availability of resources in the auction.

Clear evidence of unilateral exercise of market power, coordinated behavior or concerted entry deterrence may subject to antitrust enforcement or to the jurisdiction of the FERC. To the extent that the ISO would want to have measures within the CRAM that could be used as a deterrent to such behavior, the following are possible measures:

1. We recommended in Section 7.3.1 that bidders make their representations upon qualification that they would be bidding independently and that would be competing actively against each other. Bidders that are found to have violated these representations could be subject to financial penalties or could be required to act as a price-taker as a condition of participation in future auctions.

2. Bidders that are found to have coordinated to achieve a high price outcome could be constrained in future auction by a floor on the amount by which they are allowed to reduce their amount bid, as described in Section 7.3.4.

Precise measures would depend on the undertakings of bidders upon qualification and on possible sanctions outside of the CRAM process.

8. VARIABLE RESOURCE REQUIREMENT

One of the requirements of the RFP is that the recommended auction format be examined in conjunction with a 'variable resource requirement', or VRR, and that recommendations be provided as to the compatibility with a VRR and the advantages and disadvantages of incorporating the VRR.

In this section we explain from a historical perspective what the variable resource requirement is and how it has emerged.

We proceed to examine whether it is feasible to add the variable resource requirement to our recommended auction format for the CRAM. We find that choosing a clock auction format is compatible with introducing a VRR.

Compatibility of course does not immediately imply that the VRR would be a necessary or beneficial supplement to the proposed CRAM auction. We therefore analyze what the differences are between the current capacity markets in which the VRR has been introduced, and the CRAM. We find that the differences are significant. We believe that the VRR introduced by the NYISO addresses some of the questions by the RAM group. However, it takes a substantially different approach to resource adequacy that would make the VRR more of a complement than a substitute for CRAM.

We continue in this section to analyze the academic literature relevant to a variable resource requirement.

8.1. Variable Reserve Requirements in the New York Capacity Markets

Historically the variable reserve requirement ("VRR") has been in discussion in the area of the New York ISO. Two excellent documents describing the benefits of the variable resource requirement are the affidavits by David Patton (March 21, 2003)[21] and Thomas Paynter (April 11, 2003)[22] in the contexts of hearings before the New York Public Utilities commission. The VRR was implemented in June 2003 and at the time of writing we have reviewed three auctions that were run with the VRR.

Before the introduction of the VRR the New York ISO ran a six-monthly capacity auction (May-to-October and November-to-April), a monthly capacity auction for the remainder of the

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[21] Available at http://ferris.ferc.gov/idmws/common/opennat.asp?fileID=9675700

[22] Available at http://www.potomaceconomics.com/nyiso/Patton%20Supplemental%20DC%20Affidavit_final.pdf

ongoing six-month capability period (in May for June-to-October, in June for July-to-October, etc.) and a centralized deficiency auction.

In the six-monthly and monthly capacity auctions, generators with excess capacity could offer capacity; LSEs who were deficient could attempt to procure capacity. It is important to realize that these auctions were not auctions of 'last resort'. If bidders who were deficient in capacity could not procure capacity in the six-month ahead or the month-ahead auctions, they still had the possibility to sign additional bilateral contracts. Also, demand conditions for their own load might have changed before the supply period.

Prior to each month, each LSE had to provide contracts to demonstrate to the NYISO that it was covering its capacity requirement for the month. If an LSE was found to be deficient, then the NYISO attempted to procure its quantity in a 'centralized' last resort auction (the deficiency auction), into which the NYISO bid in all the deficient capacity at the deficiency charge, i.e. the penalty charge which the LSE would incur if it remained deficient of its obligation. LSEs that had excess capacity available could offer it in that auction. The auction represented what might be called a 'vertical demand curve'. The ISO demanded a fixed quantity of capacity and resource providers or LSEs with spare capacity bid supply schedules against it.

The experience of the deficiency auction was that prices were either at the deficiency charge or very close to zero. When there was insufficient capacity available, the price was determined by the demand side, which, as discussed, was bid into the auction at the deficiency charge. When there was excess capacity available, then LSEs offering capacity competed down the payment for that excess capacity to close to zero. It was therefore felt that the auction did not give a reasonable price signal that could attract new generation capacity into the market; and that the auction design did not give the right bidding incentives to resource providers, since in cases in which excess supply was quite small, resource providers were effectively given the overwhelming incentive to withhold some supply in order to drive the auction price up to the deficiency charge.

The New York ISO therefore introduced the VRR. Under the new arrangement, the six-monthly and monthly auctions continue to operate in the same way. They are double auctions in which LSEs bid for supply and resource providers offer supply. In that sense, those auctions already generate downward-sloping demand and upward-sloping supply curves. The deficiency auction, however, has been replaced with an auction in which instead of a fixed requirement the VRR is being procured.

The VRR auction works in the form of what might by termed 'downward sloping demand curve'. In fact, the demand curve is not completely downward sloping, since it is capped at the deficiency charge. It has two segments. The deficiency charge segment is flat with price equal to the administratively set deficiency charge. The downward sloping segment of the demand curve is determined by two points. The first is defined by the minimum capacity requirement and a percentage (currently 60% but intended to increase) of the estimated cost of a CT in the zone. This point is called the 'reference point'. Ultimately, the intent is for the reference point to also include an offset for energy and AS net revenues. The second is the amount of capacity at which the price is zero. That level is currently set at 12% excess over the minimum requirement. The downward sloping segment of the demand curve is found by drawing a straight line through the reference point and the point at which the price is zero.

The experience with the VRR over the first three months has been that prices in the deficiency auction have increased markedly. Given the moderate recovery of the New York economy, no conditions of tight supply were encountered, so that under the old deficiency arrangement the price could have been expected to be close to zero. Currently the auction clears at levels that represent about 30% to 40% of the estimated fixed costs of a CT in the respective zone. The new format of the deficiency auction also has had a knock-on effect on the six-monthly and one-monthly auctions. The deficiency auction effectively provides a floor for prices in those auctions, presumably because resource providers can use the deficiency auction as an outside option when bidding in the six-monthly and monthly auctions.

It is hoped that the increased prices for fixed capacity sends an attractive price signal to potential new resource provider to enter the New York market.

The VRR is intended to avoid the cliff effect that had been experienced in prior deficiency auctions of clearing at the cap or near zero. This will provide an incentive for existing resources to remain operating in periods of excess supply. The VRR also mitigates the incentive to withhold as the revenue gain from withholding capacity under the VRR is lower than the revenue gain absent the VRR. Finally, the VRR recognizes that capacity in excess of that needed to just met adequacy requirements continues to have value in that it further enhances reliability and moderates energy and AS prices.

8.2. Feasibility and Compatibility of the VRR with Recommended Auction Format

It is important to evaluate whether it is feasible in a 'mechanical' sense to introduce the VRR into our recommended auction format of a descending clock auction. This would for example allow all of the ISOs to follow our recommendation on the auction format and still give the flexibility to any of the ISOs to introduce a VRR.

The New York ISO move to the VRR with a uniform price 'reverse English' auction shows that a sealed bid format is compatible with the VRR.

We believe that also our recommended format of a clock auction is compatible with a VRR. We provide two figures that provide some intuition regarding how this would work. Figure 8-1 demonstrates how the clock auction would work with a VRR by illustrating how the price ticks down. Note that the size of the price drop depends on the amount of excess supply in the market. This will speed convergence to the equilibrium price. Figure 8-2 demonstrates how bidders are intended to be motivated to switch between multiple auctions and thus achieve greater efficiency by ensuring that bidders are able to react to price signals across auctions. In the next section, we provide more details on how a clock auction can work with a VRR.

Figure 8-1.
How Price Ticks Down with a VRR

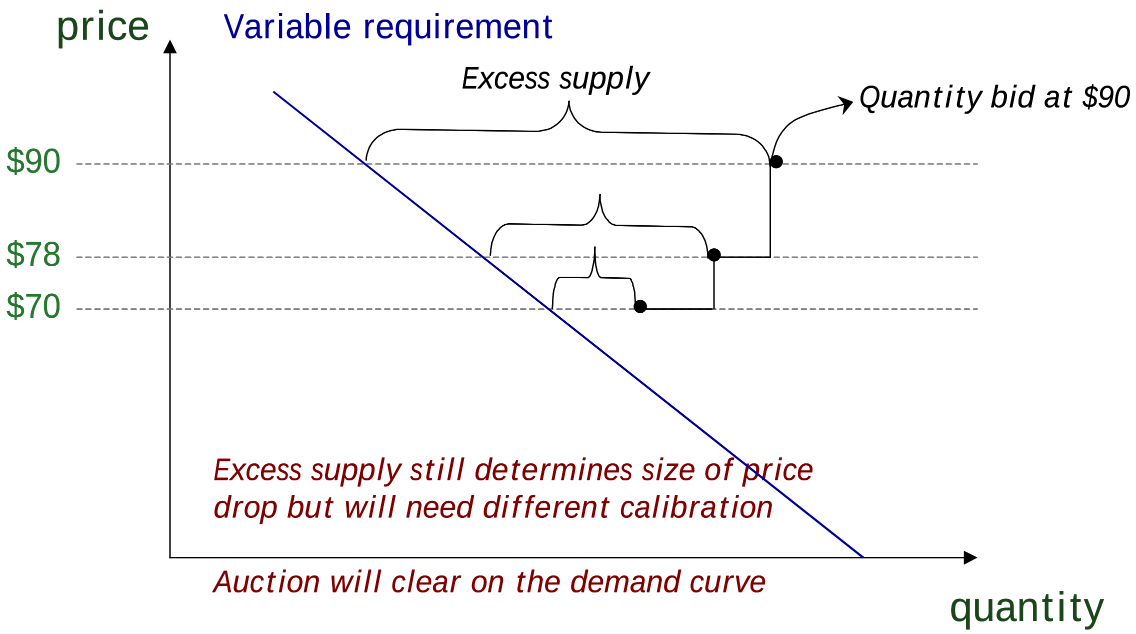
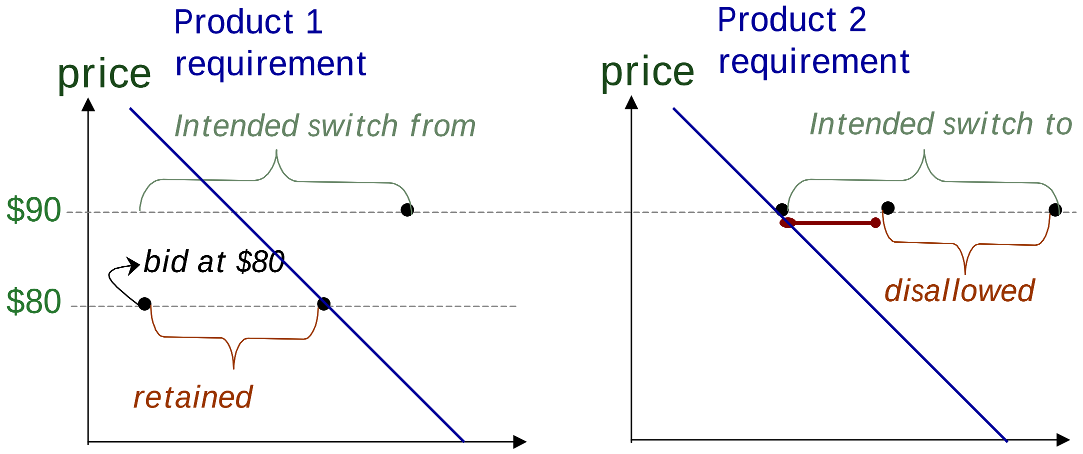


Figure 8-2.
Switching with VRRs



8.2.1. Example of a clock auction with a VRR

There are two zones in the example, zone A and zone B. The auction is run as a simultaneous clock auction. Bidding in both zone A and zone B is concurrent, and, subject to sufficient supply, bidders can switch capacity from one zone to the other during the auction. In both zones a VRR is being procured.

Our example is set up such that in both zones there is an incumbent firm, which has a supply function, i.e. the incumbent is willing to supply larger quantities at higher prices. Moreover, there are two potential entrants that want to enter with a fixed quantity in either zone A or zone B but not both.

Demand conditions in the example

	Zone A	***Zone B***
Minimum requirement	15,000 MW at cost of $120/kW-year	7,500 MW at cost of $45/kW-year
Point at which price = 0	18,000 MW (15,000 MW plus 20%)	9,000 MW (7,500 MW plus 20%)
Resulting demand curve ($/kW-year)	price = 720 – 0.04*quantity	price = 270 – 0.03*quantity

Supply conditions in the example

	Zone A	***Zone B***
Supply by incumbents	price = 0.01*quantity	price = 0.005*quantity
Supply by entrant 1	Cost of 1,000 MW is 120 $/kW-year	Cost of 1,000 MW is 45$/kW-year
Supply by entrant 2	Cost of 1,100 MW is 120 $/kW-year	Cost of 1,100 MW is 32 $/kW-year

Round 1

Assume bidders' initial eligibility is as follows:

Bidder	***Eligibility***
Incumbent	31,000 MW
Entrant 1	1,000 MW
Entrant 2	1,100 MW

	Zone A	***Zone B***
Round 1 price	$160.00	$75.00
Demand	14,000 MW	6,500 MW
Bid at current price by incumbent	16,000 MW	15,000 MW
Bid at current price by entrant 1	1,000 MW	0
Bid at current price by entrant 2	0	1,100 MW
Bid report to incumbent	16,000 MW @ $160.00	15,000 MW @ $75.00
Bid report to entrant 1	1,000 MW @ $160.00	0
Bid report to entrant 2	0	1,100 MW @ 75
Excess supply	3,000 MW	9,600 MW

Entrant 1 bid 1,000 MW in zone A since this yields a profit of 40 $/kW-year (=160$/kW-year - 120$/kW-year) and zone B would only yield 30$/kW-year (75$/kW-year -45$/kW-year). Entrant 2 bid 1,100 MW in zone B since this yields a profit of 43$/kW-year (=75$/kW-year - 32$/kW-year) and zone A would only yield 40$/kW-year = (160$/kW-year -120$/kW-year).

With these bids there is excess supply in both zones at the current prices. The bid decrement rule is a 10% decrease of the current price when excess supply is positive. The current price is thus decreased by 10% in both zones.

Round 2

Bidders' eligibility is given by the quantities bid in round 1. In general we calculate eligibility as the sum of bids at the current price and retained bids.

Bidder	***Eligibility***
Incumbent	31,000 MW
Entrant 1	1,000 MW
Entrant 2	1,100 MW

	Zone A	***Zone B***
Current price	$144.00	$67.50
Demand	14,400 MW	6,750 MW
Bid at current price by incumbent	14,400 MW	13,500 MW
Bid at current price by entrant 1	1,000 MW	0
Bid at current price by entrant 2	0	1,100 MW
Bid report to incumbent	14,400 MW @ $144.00	9,750 MW @ $67.50
Bid report to entrant 1	1,000 MW @ $144.00	0
Bid report to entrant 2	0	1,100 MW @ $67.50
Excess supply	1,000 MW	7,850 MW

At the current prices in round 2, demand has increased relative to round 1. The incumbent submits exit bids for 1600 MW in zone A and 1500 MW in zone B. However, there is still excess supply in both zones at the current prices. The incumbent's exit bids are thus accepted and the current prices are decreased by 10% in both zones.

Round 3

Bidders' eligibility is given by the quantities bid in round 2.

Bidder	***Eligibility***
Incumbent	27,900 MW
Entrant 1	1,000 MW
Entrant 2	1,100 MW

	Zone A	*Zone B*
Current price	$129.60	$60.75
Demand	14,760 MW	6,975 MW
Bid at current price by incumbent	12,960 MW	12,150 MW
Bid at current price by entrant 1	0	1,000 MW
Bid at current price by entrant 2	0	1,100 MW
Bid report to incumbent	12,960 MW @ $129.60 and 800 MW retained exit @ $144.00	12,150 MW @ $60.75
Bid report to entrant 1	1,000 MW retained switch @ $144.00	0
Bid report to entrant 2	0	1,100 MW @ $60.75
Excess supply	0	6,275 MW

Entrant 1 wants to switch to zone B at the current prices. Zone B would yield a profit of 15.75 $/kW-year (=60.75$/kW-year -45$/kW-year) and zone A would only yield a profit of 9.6$/kW-year (=129.6$/kW-year -120$/kW-year). However, this switch would imply excess demand in zone A. So in order to ensure that enough capacity will be procured in zone A, some of the actions that bidders intended to carry out are denied and some of their previous round bids are retained. We assume that bids are retained in the following order: First, retain the bid of the largest quantity. If this is not sufficient, then retain the second largest bid and so on. With this rule, entrant 1's bid from round 2 is retained and 800 MW of the incumbent's bid from round 2 are retained. There is still excess supply in zone B and the current price is decreased by 10%.

We fast forward to the last stages of the auction.

Round 8

Bidders' eligibility is given by the quantities bid in round 7.

Bidder	*Eligibility*
Incumbent	21,632 MW
Entrant 1	1,000 MW
Entrant 2	1,100 MW

	Zone A	*Zone B*
Current price	$129.60	$35.87
Demand	14,760 MW	7,804 MW
Bid at current price by incumbent	12,960 MW	7,174 MW
Bid at current price by entrant 1	1,000 MW	0
Bid at current price by entrant 2	1,100 MW	0
Bid report to incumbent	12,960 MW @ $129.60	630 MW r.e. @ $39.86 and 7,174 MW @ $35.87
Bid report to entrant 1	1,000 MW	0
Bid report to entrant 2	1,100 MW	0
Excess supply	300 MW	0

Entrant 1, who has had 1,000 MW released, chooses to bid 1,000 MW in zone A at the current price. This yields a profit of 9.6 $/kW-year (=129.6$/kW-year -120$/kW-year) relative to a negative profit of -9.13$/kW-year (=35.87$/kW-year -45$/kW-year) in zone B.

In zone B, the incumbent has reduced his bid below the demanded quantity. Some of his MWs bid in the previous rounds are therefore retained.

There is excess supply in zone A and the current price is reduced.

Round 9

Bidders′ eligibility is given by the quantities bid in round 8.

Bidder	*Eligibility*
Incumbent	20,764 MW
Entrant 1	1,000 MW
Entrant 2	1,100 MW

	Zone A	*Zone B*
Current price	$117.59	$35.87
Demand	15,060 MW	7,804 MW
Bid at current price by incumbent	11,759 MW	7,174 MW
Bid at current price by entrant 1	0	0
Bid at current price by entrant 2	0	1,100 MW
Bid report to incumbent	11,759 MW @ $117.59 and 1,201 MW r.e. @ $129.60	797 MW r.e. @ $39.86 and 7,174 MW @ $35.87
Bid report to entrant 1	1,000 MW r.e. @ $129.60	0
Bid report to entrant 2	1,100 MW r.e. @ $129.60	0
Excess supply	0	0

Both entrants do not accept the new current price in zone A and the incumbent reduces his bid. This caused excess demand and bids have to be retained.

There is a constraint on the bid decrement in this round. When there is excess demand for a product, and the current price is decreased in the next round, the decrement may cause the demand to increase to a level above the current bids, in which case there will not be enough supply to retain in order to keep supply >= demand. To avoid this situation we never reduce the current price to a level, which would implies that demand is larger than current bids (bids at the current price and retained bids).

Following Round 9, there is no excess supply in any zone and the auction stops.

The example illustrates that, while some adjustments need to be made, our recommended format of a clock auction can accommodate the VRR.

8.3. Analysis of VRR

There are three logical steps we carried out in an analysis of a VRR. Firstly, we assessed the differences of the deficiency auction with the CRAM in order to see whether the same reasoning can be applied for the long-term capacity auctions. Secondly, we analyzed the effectiveness of the VRR of the New York deficiency auction. Thirdly, we investigated whether there are any additional factors related to the particular nature of the long-term capacity market that would speak in favor or against the introduction of a VRR.

8.3.1. Differences Between the Current Short-term Capacity Markets and CRAM

In addition to the NYISO, whose capacity markets we have described above, PJM also operates short-term capacity markets. The ISO-NE had a capacity market that was suspended in June of 2000. It now operates an ICAP market that is revised from its original design

The PJM capacity credit market consists of daily and monthly markets, in which market participants can buy and sell capacity credits through a process that establishes a market clearing price.

- ***Monthly market operation:*** A monthly market may cover a period of one month or multiple months. The monthly market is a voluntary market where LSEs can plan ahead to match their capacity obligations with capacity credits.
- ***Daily market operation:*** The daily market is a day-ahead market. The daily market is useful so that LSEs can update and fine-tune their capacity positions on a daily basis, as retail loads are won and lost, and capacity contracts come on-stream or off-stream. The daily market is conducted based on the position of a participant for the market day estimated on the day the market is run. If a participant has a deficient position, PJM will only accept buy bids up to the deficiency amount. If a participant has an excess position, PJM will only accept sell offers up to the excess amount. Buy bids or sell offers are accepted into the daily market in order of priority. PJM strives to clear the market and post market results by 12:00 P.M. on the day the market is run.

The PJM and NY-ISO capacity markets work by allowing sellers and buyers of capacity submit supply and demand schedules of capacity. The market is a single bid market --, i.e., bidders submit their supply schedule bid once (rather than say, a multi-round bid market, where bids and offers for the auction are adjusted in response to information provided as a result of the auction). The PJM capacity markets are conducted with typical lead times or planning horizons of at most three months and the longest commitment period is the PJM one-year market. We think the following differences between the short-term capacity markets and the long-term capacity auction are important to note:

- The capacity markets are two sided, whereas CRAM is proposed to be one-sided or ‘centralized’, with the ISOs procuring a fixed amount of capacity.[23] In general, two-sided markets, also called ‘double auctions’, are basically designed as single sealed bid markets. This is to a large extent also the model of stock markets, which can be viewed as sealed bid auctions after every new arrival of information. Open double auctions are very rare. Bargaining situations, when one buyer and one seller attempt to agree on a-mutually acceptable price are very simple open double auctions. However, in energy or other utilities markets, where multiple units are for sale and there are multiple buyers and sellers, such a design is not prominent. In contrast, open ‘centralized’ auctions, similar to Sotheby’s or Christie’s art auctions, are widespread in many industries.

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[23] The long-term capacity auctions are therefore closer to the new NY-ISO deficiency auction. In NY-ISO parlor, they are ‘centralized auctions’.

- The capacity markets operate in relatively short intervals and are repeated quite often. The frequent repetition allows for the formation and dissemination of relevant information and lets bidders develop bidding strategies based on past auction behavior. In contrast, long-term capacity auctions would be relatively infrequent and quite in advance of the commitment period. Moreover, commitment periods would be quite spread out. Therefore, the information that can be extracted from a previous long-term capacity auction may be much more limited. This is particularly true for the first auctions that would happen before the first commitment period of the first auction takes place. For this reason, it appears less important that the short-term capacity market design reveals information of bidders′ estimates of the value of capacity during the bidding process.

- The PJM capacity markets also operate with different maturities. There is a 12-month, 6-month and 1-month market, as well as a daily market. The NY-ISO operates six-month, multiple months up to six months, and monthly capacity markets. Such a set-up allows bidders to reverse decisions later on as new information arises and therefore reduces the need for using an auction design that maximizes the amount of information.

- Only a fraction of capacity is traded in the short-term capacity markets. Much capacity is already committed bilaterally or is self-provided. The relative thinness of the market may have an effect on the competitiveness of the markets. If only small amounts of capacity are traded amongst a small number of companies, it may be possible to exert market power. Competition in the capacity markets was one of the concerns of the PJM Year 2002 Market Monitoring Reports. However, in the long-term capacity auctions, the market volume would be substantially greater, since the unforced capacity obligation for the entire region, would be procured in the centralized auction(s). Capacity purchased through bilateral contracts is expected to also be offered in the centralized auction. Therefore the competitive conditions are likely to be different.

- There is a significant difference with the intent of the VRR and the CRAM. While the VRR attempts to give more favorable incentives for entry, the CRAM, procures the capacity directly. In other words, while the VRR attempts to solicit entry, the CRAM procures and assures entry. The price signaling in the CRAM relates to prices bid on in the auction itself, and the expectation of future net revenue that is not insured through the CRAM. The CRAM is in this way a much more direct tool than the VRR.

- We reviewed anonymous bidding data for 198 monthly/multi-monthly capacity auctions in PJM and analyzed these auctions in terms of the competitiveness and bidding behavior. A few themes emerged.

  - Bidders appear to ′play the sequential auction game′. There is evidence of bidders seeking and clearing 100 MW of capacity for a given period, and subsequently seeking another 100 MW for the same period. Bidders often get the sequencing wrong. They sometimes would have paid less for capacity by bidding for all of their needs in the first auction.

- As also evidenced in the market monitoring reports, attempts at collusion usually fail and, on the whole, the auctions can be judged to be competitive.
- Prices appear to be driven by transient events and are very volatile; prices appear to follow energy market prices.
- There is evidence that prices do not necessarily indicate the demand / unforced capacity supply balance. For example, one can find situations in which the same amount of supply and demand (for the same product involving the same delivery time frame) are offered in auctions held at different times, but at very different prices. This seems to suggest that the current prices in the energy market seem to have a substantial effect on the value of short-term capacity. We would obviously not expect such price volatility in CRAM, since contracts are long-term, not seasonal, and forward-looking. We would therefore expect bidding to be driven less by existing energy market spot prices (and short term opportunities).

With these differences in scope and structure, one should be wary as regards to the direct applicability of the current market formats for capacity auctions to long-term capacity auctions. The requirements on the short-term capacity markets are different, so the best design for these markets may also differ from the best design for the long-term capacity auctions. The VRR was introduced to deal with some of the problems that came out of short-term capacity auctions. It is not clear that the same issues would arise in CRAM, or that the VRR would be the right tool to address those issues.

8.3.2. The VRR in the New York market

The empirical evidence of the VRR in New York is still too short. If the VRR helps to attract new capacity to New York and if the new capacity means that in conditions of peak demand, energy prices become less spiky and therefore lower on average, then the VRR may be seen as a success.

The lack of data so far means that we need to look more at some of the theoretical arguments underpinning the VRR. It is useful for this analysis to treat separately the two parts of the downward-sloping demand curve that lie to the right and to the left of the reference point.

To the right side of the reference point, the demand curve has the effect of not letting the reference price go to zero immediately. Instead, more capacity is procured at higher prices. For the immediate market situation that the deficiency auction is trying to address, namely the sufficiency of capacity, the demand for the additional capacity can be justified in part b reliability improvements. The minimum requirement sets the quality of service (one day outage in ten years). All additional capacity improves on the outage parameter. However, it has been widely established that the reliability improvement declines exponentially and not linearly with excess reserves and hence the VRR would significantly overvalue the reliability improvement from additional reserves. The chart in Figure 8-3 below shows the relationship between reserves and LOLH for the New York ISO.

Figure 8-3
Relationship between Reserve Margins and LOLH[24]

	Reserve Margin	**LOLH**
1992	26%	0.57
1993	30%	0.58
1994	36%	0.1
1995	36%	0.01
1996	35%	0.03
1997	34%	0.04
1998	33%	0.1
1999	30%	0.37
2000	29%	0.42
2001	28%	1.03
2002	27%	1.44
2003	25%	1.81
2004	24%	4.06
2005	22%	6.28
2006	21%	7.63
2007	20%	14.39

Therefore the benefit of procuring more capacity must also come from somewhere else in order to justify the VRR. The two obvious candidates are that, in some way, the VRR induces added capacity that lowers prices in the energy spot market and that the VRR serves as market power mitigation tool. In fact, the affidavits filed by the New York ISO in support of the demand curve indicate that excess reserves do lead to lower energy prices and that these savings will offset a portion of the extra capacity market costs. Further, current conditions in the New York ISO market do not provide for significant energy profits for many units and if in addition capacity market revenues are low, financially constrained generators may be unable to maintain

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[24] "LOLH " is the acronym for "Loss of Load Hours".

plant operation. It may be less expensive to provide capacity payments that maintain the short-term viability of generating plants as opposed to having such plants retire and accelerate the need for entry.

To the left side of the reference point, we encounter the problem that not enough capacity will be procured in order to guarantee the quality parameter given by the minimum requirement. The ISO needs to procure that capacity elsewhere. In a sense, the demand curve is really vertical from the minimum requirement point to the left, since the minimum requirement is the real minimum requirement. If the ISO procures capacity after the auction, then one may ask what the need is for the sloping demand curve to the left of the minimum requirement point. Nonetheless, the slope does reduce the incentive to withhold capacity and sets the market-clearing price for most capacity at a level lower than that required for supplemental procurements.

8.3.3. Alternative interpretations of the VRR in the long-term capacity auction

While we have illustrated significant differences of the short-term and long-term capacity markets and the applicability of the VRR for the long-term auction, we think that for the long-term auction, the VRR can be interpreted in two alternative ways.

The first such interpretation could be that, given the recommended planning horizon, the ISOs may be uncertain regarding the needed capacity growth. The ISOs could address that issue with a VRR. More certainty that the capacity is needed means that the ISOs will want to procure that amount of capacity at a higher price. As more capacity is offered (we move to the right on the 'demand curve') it becomes increasingly less certain that the capacity will really be needed in the commitment period. Therefore the ISOs would only wish to pay a lower price.

Secondly, as illustrated in a recent article by Marco LiCalzi and Alessandro Pavan[25], the VRR can also be interpreted as a measure to ensure competition. As we remark in the section on mitigation and monitoring, multiple unit auctions allow for collusive equilibria. The collusive equilibria consist of bidders submitting 'steeper' supply curves than would be merited by their costs. If every bidder submits a steeper supply curve, it will have the effect that the aggregate supply curve is also steeper. This means both that there can be a higher price, but at the same time, should anyone deviate by throwing a lot of supply on the market, the steepness means that the price will fall precipitously. In this way, deviation from a collusive price is punished. The steepness of the other bidders' bids make it costly to submit a low bid. It is this punishment

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[25] Marco LiCalzi and Alessandro Pavan, "Tilting the Supply Schedule to Enhance Competition in Uniform-Price Auctions", Northwestern University Working Paper, 2002

that sustains the steep/high price strategy as an equilibrium, i.e. a situation from which no bidder would want to deviate.

With a VRR, there is however not only a price effect (submitting a lower bid dramatically lowers the price), but also a quantity effect: submitting a lower bid now also increases the quantity demanded and therefore the quantity potentially won by the bidder who deviates from the collusive high bid strategy. By increasing the quantity, it can have a positive effect on revenue for a deviating bidder. LiCalzi and Pavan show that, indeed, this mechanism allows for the elimination of a number of low-price collusive strategies. We need to emphasize that the result is for single sealed bid auctions. There are some indications in the literature that the mechanism of step-bids that are characteristic of a clock auction may also prevent low price collusive equilibria from arising[26].

8.3.4. Evaluation of Incorporating the VRR in to the CRAM Given NERA's Recommendations on Planning Horizon and Mitigation

The VRR shares many of the objectives of the CRAM and as discussed above could be combined with the Auction Format recommended by NERA. In this subsection we address the necessity and desirability of adding the VRR to the auction format and to the CRAM as formulated based on NERA's recommendations with respect to planning horizon and monitoring and mitigation. This review is conducted relative to the CRAM objectives as well relative to other factors related to achieving those objectives. In conducting this review we first assume that the VRR would be added to the CRAM as recommended by NERA. We then briefly discuss the VRR in the context of a CRAM that does incorporate the planning horizon recommended by NERA.

8.3.4.1. Assuring Adequacy

The key objective of the CRAM is to assure that adequate capacity is developed to provide for minimum supply adequacy. The CRAM model, as recommended by NERA, would achieve that goal by relying on a three year planning horizon to allow for new capacity to be developed and by permitting the market to reveal the price required for adequacy through not mitigating prices that are set by competition among entrants. Only the market can reveal the price required to induce entry given the substantial uncertainty over how bidders will evaluate the risks of long term ownership and what effective residual value or amortization period will be reflected in competitive bids. Adding a VRR to the CRAM poses the difficulty that the price at each level of installed capacity must be specified and that specification starts by estimating the net cost of entry (price required to induce entry) and using that price as the price that will be paid at the target minimum level for adequacy. The price would increase as less capacity is

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[26] Garcia-Diaz, A. And P. Marin (2003) "Strategic bidding in electricity pools with short-lived bids: an ***application to the Spanish market", International Journal of Industrial Organization 21, 201-222.***

available and the price would decrease and the volume purchased would increase if more capacity were offered. This feature of the VRR makes the objective of assuring adequacy less certain. If the estimated price required to induce entry is underestimated, sufficient offers to maintain adequacy will not be forthcoming and the CRAM with a VRR will not ensure adequacy. Hence, from the perspective of this objective, the CRAM would better serve the purpose without the VRR.

8.3.4.2. Revealing The Market Price For Adequacy

Another objective of the CRAM is to reveal the market price for adequacy. Under the CRAM as recommended by NERA, monitoring and mitigation methods (including the price cap that would be employed if there are insufficient offers for a competitive auction) that will be followed are revealed to bidders and developers of new capacity, who factor these considerations in their cost and market expectations to make offers that reveal the market price for sufficient capacity to just meet the adequacy requirement. Prices that result from competition that includes qualified new capacity reveal the price for adequacy and are not mitigated. Were the VRR to be added, prices would need to be pre-specified and the market would reveal its willingness to supply at those prices. While this would provide valuable market information from which the price for adequacy may be able to be inferred, it would not directly reveal the market price for adequacy. Hence with respect to this objective, the CRAM without the VRR would better serve the purpose.

8.3.4.3. Minimizing Market Power and Gaming Options

The CRAM as recommended by NERA has specific monitoring and mitigation alternatives that will serve to check market power including an administrative price if supply is insufficient, reserve price alternatives if competition is limited (including a sliding scale reserve price that is similar to the demand curve as explained in Section 8.1 and the option of monitoring based on incremental costs. The VRR also provides for monitoring. The VRR addresses mitigation differently by directly reducing the incentive to withhold by limiting the profitability of withholding. In effect the VRR has reserve prices that apply to various levels of capacity and withholding becomes less profitable because under the VRR withheld capacity would be sacrificing less revenue under the VRR as opposed to the CRAM without the VRR. However, there is no assurance that the total capacity market payments under the VRR would be lower than CRAM without the VRR. Total payments could be lower under the CRAM without the VRR, even if more capacity was withheld to increase the price at the volume purchased. Further, as the VRR sets the price at each point there is no assurance that the price realized for any given capacity level may well be lower without the VRR than with the VRR. For example, it is possible that if the minimum requirement was set at 22%, an auction without a VRR could possibly result in a lower price than the price set for the VRR at 22%, even given some degree of market power. This is the case because the VRR sets the price administratively and at each point may overestimate the required price. With respect to this objective, we do not believe that adding the VRR to the CRAM is needed to further mitigate market power and are concerned that the mitigation properties of the VRR are blunt and while incentives to withhold are reduced, the requirement to set prices at each supply level could well lead to higher prices at some levels.

8.3.4.4. Achieving Reasonable Prices

While not an explicit goal of the CRAM process, we believe that obtaining a market price implies obtaining the lowest reasonable price. The VRR does put a floor on the price in times of surplus capacity. The CRAM does not have such a floor. In this regard, the floor provided by the VRR may well provide greater investor certainty with respect to capacity prices during periods of excess and hence could help to lower prices that would be required by entrants. NERA does not believe that the CRAM with a three-year planning horizon would in fact lead to prices collapsing to very low levels as a result of moderate capacity surpluses. This is the case because in all ISOs there is a significant quantity of older capacity that has significant going forward costs that would require higher prices. Given the short lead times of current auctions, this capacity has virtually no going forward costs with respect to providing capacity. To the extent that the VRR provides investors with greater comfort than the CRAM without the VRR that price would not collapse, it could be a useful addition to the CRAM, especially to help provide confidence in the early stages of the market. However, given substantial capacity surpluses one would expect capacity prices to be low and to provide a signal for retirement. The VRR could possibly provide an artificial price support.

8.3.4.5. Compatibility With Retail Access

The addition of the VRR would further complicate the ability of LSEs to hedge with self-supply or bilateral. This is the case because with the VRR the volume of capacity required to implement a hedge is more uncertain. On this objective the VRR is not a beneficial addition to the CRAM.

8.3.4.6. Resource Non Discrimination

An acknowledged issue with respect to the CRAM as recommended by NERA is that it will be very difficult for demand resources, as currently provided, to make the commitment to a three-year planning horizon. Adding the VRR to the CRAM as recommended by NERA would not change this. Hence, the VRR as an addition to the CRAM is neutral.

8.3.4.7. Achieving the Most Efficient Outcome

This was not an explicit objective of the CRAM. However, we have elected to analyze the VRR from this perspective, as there is an argument that adding the VRR to the CRAM would increase the efficiency of the end result. Specifically, the target reserve level is based on a reliability level of one day in ten years and this incorporates a judgment that the marginal cost of capacity equates to the marginal cost of unserved energy at this reliability level. The marginal cost of capacity, however, can only be revealed by the market. If in fact capacity is less expensive than thought, it would be more efficient to procure more capacity and realize a higher reliability level. Without the VRR, the volume is not dynamic and reliability will always be procured to the one day in ten level, even if it would be more economically efficient to buy less or more reliability. The VRR could provide for this. In particular if the VRR was determined so that price reflected the social value of added capacity in terms of reducing the economic costs of outages, the auction process could reveal the efficient or socially optimally level of capacity. In order to achieve this objective, it would be necessary for the VRR to be set based on the marginal value of capacity at each level of reserve. Without the VRR, the CRAM takes as given the efficiency of the one day in ten objective and seeks to obtain the market price to meet this reliability target. With the VRR, the CRAM could instead be structured to reveal the optimal level of reliability. Both perspectives are valid. The articulated CRAM objective of revealing the market price for adequacy, is we believe more consistent with a CRAM absent the VRR, but there does exist a valid alternative perspective that would be consistent with the addition of the VRR, although with a modified development of VRR values to reflect the marginal value of reliability.

The argument for the VRR in this context is most powerful when it is applied to new capacity. When the effect of the VRR is to increase capacity payments to generating units that would operate even if they did not win in a capacity auction as a result of energy and AS profits or to increase imports from existing units in other areas, no actual increase in reliability may be realized. Having added capacity under contract does not contribute significantly to reliability if those units would be operating anyway.

8.3.4.8. Summary Evaluation

In view of the above factors, we conclude that adding the VRR to the CRAM would not enhance the ability of the CRAM to achieve the objectives set forth by the RAM group. We do recognize, that there are alternative objectives that would favor the addition of the VRR to the CRAM model. The most serious deficiency of the VRR is that it requires that prices be set for each point on the supply curve. This means that if prices are incorrect it will be difficult to assure adequacy and that the CRAM will not be revealing the market price for adequacy. Hence, despite some positive aspects, we do not recommend adding the VRR to the CRAM as proposed.

In any market system there must be at least one degree of freedom, that is one variable that is not set administratively, but is determined by the market. In the CRAM, as recommended by NERA, the free variable is the price required by entrants when they compete against each other to win at the auction and win a capacity contract. This price is not mitigated and is set by market participants through a competitive process. Adding the VRR to the CRAM is a significant change. The free variable is no longer price, but quantity. All possible price levels are administratively set. The free variable is the quantity that the market will provide in response to those specified price and quantity pairs. When entry is required to assure adequacy, it will be necessary to be certain that the price quantity pairs are set so that neither too little nor too much entry is induced.

8.3.4.9. An Alternate View of the VRR

We have evaluated the VRR as an addition to the CRAM as recommended by NERA with a three-year planning horizon, three-year commitment period and monitoring and mitigation recommendations. When viewed against the RAM group objectives we do not find that the VRR is a desirable addition to the CRAM. However, we do recognize that there are alternative views. Specifically, we are aware that there is sentiment among stakeholders for a substantially shorter planning horizon and commitment period. NERA's view is that a shorter planning horizon would frustrate the ability[27] of the CRAM to assure adequacy as it would require the capacity construction commitment to be made independent of the CRAM and the adequacy would not be assured by contract but would totally depend on commitments to construction made independent of the CRAM. Further, we do not believe that price signals would be meaningful with a shorter planning horizon, that the auction would reveal the market price for adequacy or that meaningful mitigation measures could be employed. Entry would not discipline price. Instead if too much capacity had entered, prices would be driven low and below the cost of entry. If too little capacity were developed there would be no limit on price other than a price cap.

In the event that a shorter planning horizon was adopted, we would not be able to recommend that the CRAM would meet the objectives of the RAM Group. In such a case we believe that a VRR would be desirable and even necessary. While the VRR would not assure adequacy, it would provide an added incentive for capacity development that is necessary to induce entry. Specifically if a planning horizon less than two years were to be adopted, we would recommend that the VRR be seriously considered.

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[27] The RAM objectives could possibly be met with a two year planning horizon, by relying on short lead time smaller scale capacity, but at a higher price and cost.

9. COMPATIBILITY WITH RETAIL CHOICE AND BILATERAL MARKET

NERA's scope included examining whether the proposed CRAM was compatible with retail choice. A key feature of the CRAM is that LSEs would be assessed a charge based on current load obligations to cover current capacity market costs. Hence, the ISO would incur obligations in, say 2005, for capacity to be provided for the commitment period from June 2008 to May 2011. The ISO would pay suppliers for that capacity on a monthly basis during the commitment period. The ISO would charge LSEs actually serving load in the commitment period an amount equal to the payments made to suppliers based on each LSEs daily or monthly capacity obligation. As customers switched from supplier to supplier, the obligation would change and the payments made by a supplier to the ISO would decrease or increase in proportion to the load obligation.

All but one state in the area covered by the ISOs have adopted retail choice models. In most states, however, the vast majority of load is still served by Provider of Last Resort (POLR) providers. These POLR providers have no assurance that that load will not migrate to competitive retailers and in many states no assurance that customers served by competitive retailers will not return to POLR service. POLR providers do not and cannot obtain contractual commitments from customers to take long-term service. Competitive retailers could theoretically obtain such commitments, but the practical difficulties of convincing end use customers to sign such contracts, customers unwillingness to commit as well as the transaction and contract enforcement costs render such contracts the exception and not the rule. The future of POLR service is in itself uncertain. Throughout New England, in New Jersey and Maryland competitive procurement processes for terms of three years or less are the current policy. In New York, various utilities have different plans and rely on the spot market and hedges, but generally serve as the procurement agent for POLR supply. In Pennsylvania there is still significant time remaining on transition rate plans that include generation rates. There are uncertainties with respect to the future of POLR service that range all the way from the possibility of reinstituting Integrated Resource Planning (IRP) processes to assigning all customers to competitive retailers.

In the above context there is no significant buy side incentive to long-term supply contracts that would encourage investment. The CRAM process is compatible with this retail choice environment and supports that environment in that it fills the gap on the buy side and provides a framework for a contract with sufficient lead time, several years of capacity revenue certainty and the prospect of a known market framework that will persist and provide future revenue opportunities. It is compatible because the CRAM would provide contractual assurances backed by a tariff provision to charge all LSEs and hence mitigate the lack of contracting incentives and a contract structure in the current retail access environment. In fact the CRAM is the only method of providing contract support and hence assuring adequacy that is compatible with the current retail access environment.

Given NERA′s recommendations, suppliers would be assessed a charge based on the weighted average auction clearing price for each of three auctions and the values for the auction clearing prices and weights for each auction would be set three years in advance. Each ISO would then need to design a charge that collected the right amount of revenue. There are alternative methods to accomplish this. The method that would provide the greatest certainty would be to assign each customer an annual capacity obligation, to set a rate per unit of capacity obligation that recovered the total revenue required and to charge LSEs capacity obligation costs based on the actual customers served on a daily basis. The determination of the capacity obligation could be done between the end of the previous summer and the beginning of the next June to May period and would be fixed for that period. The rate could be determined to also include any added costs that the ISOs may have incurred in relation to filling gaps and to reflect any credits for deficiency payments collected as a result of contract terminations. This would enable LSEs to have reasonable certainty of the capacity cost of serving a customer in advance of the annual June to May period as well as be able to make predictions for the next several commitment periods.

This should also facilitate retail choice as the payment obligation would switch with load. Retail providers would not be making forward financial commitments based on load projections. In addition the proposal would provide retailers, and bidders in POLR procurements, with reasonable certainty as to the cost of serving a customer for the next year or years.

Hedging through a bilateral contract is possible and would require that a self-supplier or provider of capacity obtained through a bilateral contract offer the capacity in the auction. The self-supplier would then be charged the appropriate rate for capacity based on the load they actually served and receive auction revenues for self supply.

Three complications arise. First, the revenue collected would provide for recovery of all capacity payments known at the time the rate was set. To the extent that the ISOs conducted spot procurements, this may result in added costs and capacity costs would be less predictable. Spot procurements would require monthly reconciliation charges that would not be predictable in advance. There is no hedge available against these charges. Second, the rate charges will be a function of the clearing prices and volumes purchased by the ISO in three CRAM auctions as well as of supplemental procurements to fill gaps. There is no assurance that the self-supply through auction participation on the sell side will be a perfect hedge. The payments received may differ by auction and the weighting of those payments will depend on supplier participation in each auction that may differ from the weighting used to develop supplier charges. Third, while the amount of capacity bought will be known, the load over which the costs will be allocated may vary.

These issues mean that under the CRAM, the self-supply hedge would be less than exact. The notion that by offering and clearing supply in the central auction, a self-suppler or bilateral user would be fully hedged, is not exactly right. There are potential fixes to each of these issues and they are discussed below.

1. Increased or decreased charges from deviations in load forecast.

The issue is whether an individual entity should be able to exempt itself from load forecast variances. Under the CRAM, the ISOs will buy based on an aggregate forecast. We assume they will also allocate costs based on forecast load. However, only LSEs actually serving customers during the commitment period will be responsible for paying for capacity to the ISO. It is unclear how each customer will be assigned with a forecast responsibility three years in advance and how the forecast responsibility will be affected by customers that change suppliers, customers who are new or customers who shut down. Some entities may wish to bear the risk of their own forecast, and customer migration, and not the ISO forecast. If market participants believed that it was desirable to provide such an option, it may be possible to develop rules that would do so. However, in a retail access environment, such rules may be easy to game, by adjusting load through adding or shedding customers. Further permitting this option for some customers would increase uncertainty for others. For purposes of this report, we highlight the issue and leave resolution to the ISOs.

2. The weighted average price to load is based on three auctions while the payment to capacity is auction specific.

An exact hedge would require that a self-supplier bid the exact right mix in every auction, which is difficult. The magnitude of this problem is however not significant enough to change the rolling auction format to a single fixed term. To the extent that this is a significant problem for self-suppliers, the ISO could consider implementing settlement procedures that would allow designated self-supply capacity to be compensated based on the weights assigned to load from each auction as opposed to capacity. This would result in a differential adjustment (either up or down) to the amount of costs to be recovered from load. The settlement details would need to be worked through carefully. Further, it would need to be accepted that accommodating this for self suppliers would result in less price certainty for other suppliers. The certainty provided to self-suppliers would come at a cost to others. Additionally, in order to prevent gaming, there would need to be requirements that the LSE could in fact, demonstrate that the self-supply or bilateral was clearly intended for use as self-supply (perhaps through a consistent practice of self-supply) and was not declared to arbitration settlement rules.

2. The cost of supplemental procurement or revenues from deficiency charges may change the total costs to be collected and result in costs or benefits for self-suppliers who have experienced no change in their demand / supply situation.

It is possible that the ISO will incur greater costs or lesser costs depending upon whether it fills any gaps and the cost relative to deficiency charges. The issue is whether these costs should be shared by the market or if self-suppliers and bilateral users should be exempt from these deviations. As all load gets the reliability benefits of the CRAM, there are arguments for sharing these costs. If, however, the market participants feel differently, it would be necessary for the ISOs to attempt to aggregate these costs, assign load forecast deviation costs directly to self-supplier and settle differently with self-suppliers.

10. NON-DISCRIMINATION AMONG RESOURCES

An objective of the RAM Group was to not discriminate among resources types. The results of the demand resource provider survey clearly indicate that many current demand resource providers would not be able to participate in a CRAM with a three year planning horizon. A deeper analysis of the survey indicate that these problems were fundamental for many of the program participants in that they were unable to make commitments that far in to the future. While the survey must be analyzed noting that over time there would be some adaptation to the market structure and some attempt to influence the recommendations, the results are a strong indication that the three year planning horizon is a fundamental problem for most demand resources and would result in reduced participation. This is harmful both to demand resource providers and to the market as a whole as it would reduce the participation of efficient providers and increase the need for generation.

One solution is to reduce the planning horizon to one year for at least a portion of the resource adequacy requirement. This would enable more demand resources to directly participate. However, the negative effects on the ability to achieve other objectives are so strong that this is not an acceptable alternative. Introducing a short planning horizon, even for a portion of the requirement would diminish the ability to assure adequacy, would significantly change bidding incentives and complicate monitoring and mitigation and would make the auction price less meaningful as the market price required to provide adequacy. NERA does not believe that the concept of the CRAM is workable with the one year planning horizon needed to attract full demand resource participation.

We do not believe that a one-year planning horizon, that is an auction held a year before the start of the supply period, discriminates against demand resources. As the three-year planning horizon is critical to enabling the CRAM to meet objectives, it is not discriminatory to retain a critical parameter and it would be unreasonable to change a critical parameter to accommodate one group of resource providers. However, excluding demand resources from supplying capacity is unreasonable and undesirable. While individual providers can not make commitments, the ISOs can use historical experience and market information to determine the potential contribution of demand resources with a three planning horizon. The ISO could then continue or establish demand response programs that would reserve an amount of capacity to be supplied by demand resources through these programs or a shorter lead time demand resource only auction. Demand resources would also be able to participate in the CRAM auction if they chose. However, details would have to be worked out to coordinate any reservation with the decisions of demand resources to bid in the auction. Their participation would be contingent upon satisfactorily resolving this issue. Over time the capacity contribution of demand resources should become predictable and as experience is gained with the CRAM markets more demand resources may migrate to those markets. This alternative also has appeal in that the complexity of the auction and the financial requirements for participation in the CRAM auction may in themselves be a large enough hurdle to demand resource providers.

Another area where demand resources will need different consideration is in the area of qualification participation in reconfiguration auctions and deficiency charges. In our discussions of these items we have used examples that are easily applied to distinct generating resources. We would expect generation bids to be tied to specific identifiable resources and therefore qualification, determination of whether the resource was available to participate in the original centralized auction and hence ineligible to participate in a reconfiguration auction, and whether a resource's rating has changed just due to forced outage experience are all verifiable and clear cut. The application to demand resources may differ. Aggregators may offer demand resources and then sign up customers. Performance may be judged historically. It is not clear that the principles set forth with respect to generation readily translate in to requirements that easily apply to demand resources. While details are outside of NERA's scope, care will need to be taken to ensure that specific provisions of the demand resource obligation are different, but non discriminatory.

11. IMPACT OF CRAM ON ENERGY AND ANCILLARY SERVICE

NERA's scope includes an analysis of the impact of the proposed CRAM model on energy and ancillary service (AS) markets. This analysis was both theoretical and empirical.

On a theoretical basis, NERA examined interrelationships between the CRAM and the energy and AS market. We did not find any direct interrelationship that would affect how winning bidders in the CRAM market would bid in energy and AS markets. While we anticipate that capacity suppliers will have certain obligations to bid in the energy market and face certain restrictions that will enable the ISO, to retain generation from these suppliers during tight supply conditions, these conditions apply to capacity procured through the CRAM process and to capacity provided under current market rules. As these obligations apply irrespective of the CRAM implementation and design, to any capacity obligation, and have beneficial effects on energy and AS markets as they can only serve to increase the supply in those markets, there is no reason to expect that the CRAM would cause any change in those markets. The shift from current capacity markets to a CRAM does not imply any change in how capacity providers will bid in energy and AS markets. Hence, theoretically we do not see any implication of the CRAM for energy and AS markets.

If there were no capacity obligation and capacity market, there would be impacts on the energy and AS markets. These markets would be the only markets to support new investment, other than bilateral contract markets and it would be extremely difficult to have price caps and active mitigation on these markets while at the same time providing sufficient incentives for investment. In particular, it is difficult to distinguish prices in an energy only market that rise sufficiently high to induce entry and recover capital costs in times of scarcity from prices that may be affected by market power. This has proven extremely contentious in practice, and creates significant uncertainties for investors and customers. While there are strong theoretical arguments for an energy only market that lets the market determine the level of reliability and uses high spot prices to provide reliability by lowering demand, the practicality of such a solution has not been demonstrated. Hence, to the extent that doing away with the CRAM implied an energy only market, we would expect significant changes would be required in the energy and AS markets.

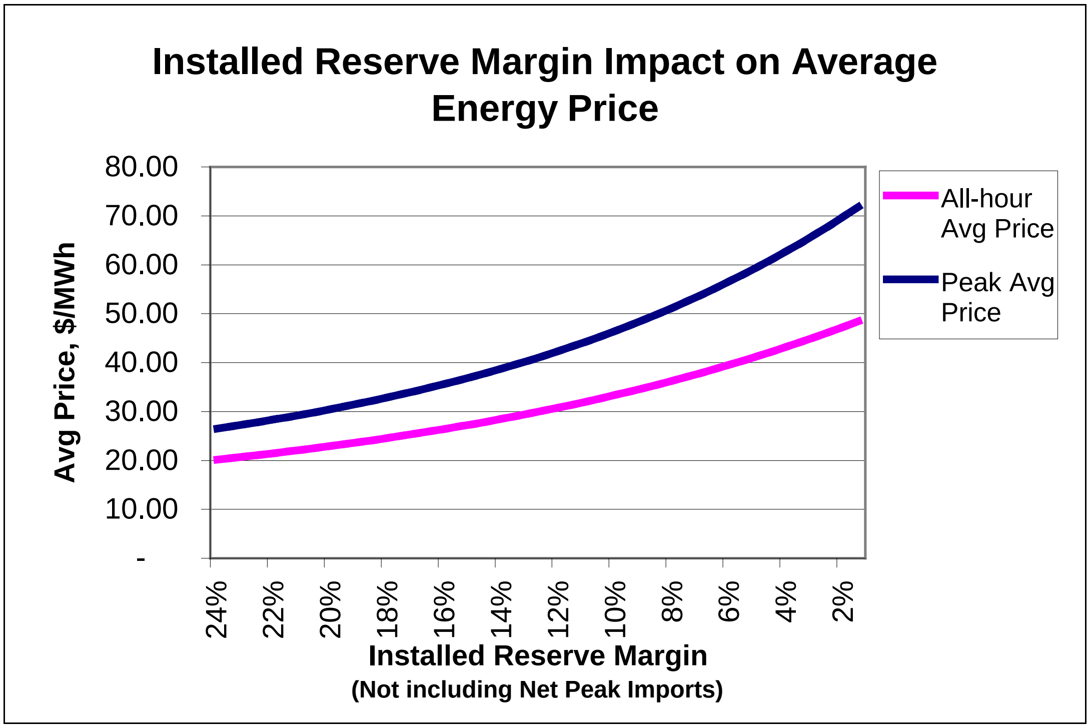
We would expect the CRAM to result in a more stable level of installed capacity relative to the current capacity markets that do not have a forward planning horizon. This is the case because energy and AS markets do not provide economic incentives for entry until reserves drop to well below the levels required for adequacy. Additionally the short lead time capacity markets currently in place have a tendency to clear at price caps or at very low levels adding to overall price volatility.

The CRAM market with a three year planning horizon will allow winning bidders to make an entry commitment prior to seeing capacity, energy and AS prices increase by locking in an assurance of capacity revenue. This should assure adequate supplies and avoid conditions of capacity shortage, which exert upward pressure on energy and AS prices. Similarly, potential entrants that do not win in a CRAM auction will have a diminished incentive to enter, as they will not be eligible for capacity payments through a ISO-administered centralized auction and given the supply adequacy assurances resulting from the CRAM market will not have expectations that entry is profitable without a capacity contract. NERA′s simulation model, discussed in Section 3 with respect to the planning horizon, indicated a narrower base of expected reserve as the CRAM planning horizon was lengthened.

Currently, with no market that acts with sufficient lead-time to influence the entry decision, entry is likely to exceed adequacy requirements in response to supply shortages and high prices leading to cycles of surplus and shortage. The CRAM would be expected to moderate these cycles.

NERA used a stochastic econometric model to estimate the impact on energy prices of various levels of installed capacity reserves. Figure 11-1 shows the results for annual peak and all-hour average energy prices in current dollars for PJM (western hub). Analysis of historical data shows that the NYISO (Zone A) and ISO-NE markets show similar price sensitivity to installed reserve levels.

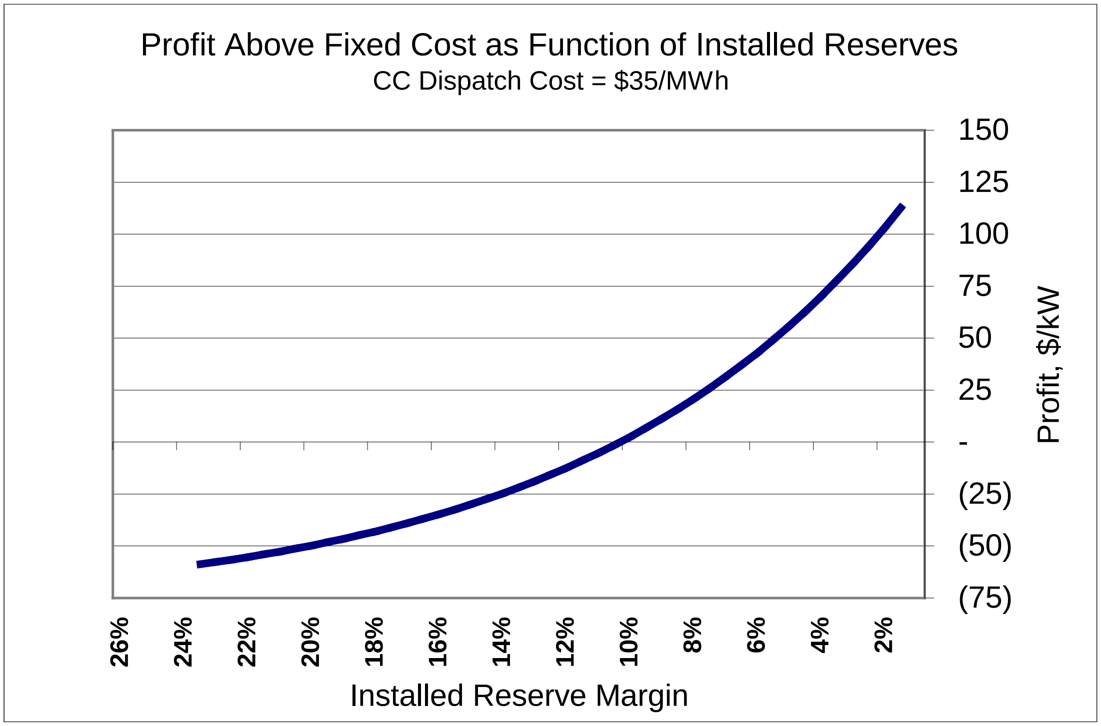
Figure 11-1.
Modeled Installed Reserves / Energy Price Relationship



As shown in the chart, peak energy prices rise quickly as installed reserves fall below the level needed for adequacy. For example, given a gas price of approximately $4.00/MMBtu for the model case, PJM on peak average energy prices at an 18% installed reserve level are $33 per MWh. At a 12% reserve level peak energy prices are $42 per MWh, an increase of 27%. While energy prices fall as the reserve increases, the relationship is not as dramatic. At a 22 percent reserve level, peak energy prices would be about $27 per MWh, a drop of 18% compared to the price at the 18% reserve level. As we expect the CRAM to maintain adequate reserve levels and to reduce variances in reserve from the target, the expected effect on energy markets of the CRAM is a reduction in price volatility.

NERA also used the stochastic econometric model to examine at what reserve level energy market profits alone would support the cost of entry. Figure 11-2 shows these results from the PJM case illustrated above. As shown in the chart, reserves would have to drop well below any levels historically experienced (to the 10% range) in order to economically support entry without a capacity market. Moreover, as we have assumed a life cycle amortization of investment costs, reserves would need to remain at this level for a protracted period. This further illustrates the need for a capacity market to provide an incentive for the entry required to maintain adequacy.

Figure 11-2.
Profit as a Function of Installed Reserves



While the above analyses were designed to provide a focused view of the impact of the CRAM on other ISO markets, NERA also examined the interrelationship between capacity and energy markets in a broader and more theoretical fashion. Appendix D to this report provides a discussion of those interrelationships.

12. RECONFIGURATION AUCTIONS, FILLING GAPS AND CAPACITY SPOT MARKETS

12.1. Overview

NERA's scope of work included developing recommendation with respect to reconfiguration auctions. In the course of considering this issue, two other related issues arose. The first is whether the ISOs should fill gaps left by resources that fail to perform. The second is whether the ISOs should / have a capacity spot market.

12.2. Reconfiguration Auctions

As the RAM model was originally presented to NERA, the reconfiguration auction was a market facilitated by the ISO in which resource providers that were deficient could meet their obligation and avoid deficiency charges by procuring capacity from resource providers that had extra capacity. The market would be facilitated by the ISOs, but would have a buy and sell side and the ISO would, unlike the CRAM, not be the buyer on behalf of LSEs.

Buyers would be auction winners who were short as a result of an inability to perform or desire to substitute a more economic resource. On the generation side, an inability to perform could result from a reduced UCAP rating due to changes in unit's EFORd, a forced derating of the facility, or failure to finish construction in a timely manner. On the demand resources side, this could result from a reduction in the baseline demand or the destruction of control equipment. Reconfiguration auctions would mitigate risk to resource providers, especially the risk of potentially large deficiency charges.

A critical issue is what resources would be eligible to sell in the reconfiguration market. A basic tenet of the auction is that to be eligible to be used as capacity to meet the region's unforced capacity obligation, resources must be offered at and clear through the centralized auction. Hence, there are no holders of capacity credits for the commitment period not already committed to the auction. The ISOs could decide to permit those that did not win in the centralized auction, to still be considered as eligible provided that they win in a reconfiguration auction or are used as substitute capacity for capacity that won at the auction. Sellers of capacity in the reconfiguration auction would need to be qualified and through qualification receive authorization to be eligible to provide capacity even though they did not participate in and win at the centralized auction. Reconfiguration capacity would be an exception to the basic principle that only resources that clear through the centralized auction provide capacity. In order to ensure the most vigorous competition in the auction, it is important that resources have a strong incentive to participate in the auction and win, and not see ready post auction opportunities.

A reconfiguration auction could be held several months prior to the beginning of the supply period in which auction winners facing an inability to supply or an opportunity to substitute an economic alternative could purchase from the eligible sellers. Buyers would submit bids, sellers would submit offers, and clearing volumes and a clearing price would be determined. Buyers who purchased capacity would pay the reconfiguration auction price to sellers, would be permitted to use such capacity to replace capacity committed to the ISOs through the centralized auction, would receive the original auction clearing price for capacity, and would be relieved of any deficiency payment related to non performance of the capacity originally cleared at the auction to the extent that replacement capacity was acquired from a resource qualified to sell in the reconfiguration auction.

NERA does not see any significant flaws in the type of proposal and believes that the proposal could provide some benefits in terms of reducing risk to auction winners and providing opportunities for resources that did not qualify for the auction or were unsuccessful to receive value for capacity. NERA recommends that prior to the supply period a reconfiguration auction be held that is:

- Two sided in that buyers bid and sellers offer;
- That clear both volume and price;
- That provides a one-year term for the next June to May period and perhaps for shorter periods if substitute capacity would be required for a shorter period;
- That, with respect to buyers, is limited to buyers who have won in the capacity auction and are seeking a substitute resource including a substitute to replace a decline in ratings due to outage experience; and
- That contains a qualification process that requires substitute capacity to meet all qualification requirements applicable to capacity providers.

The timing of the reconfiguration auction should coincide with changes in UCAP ratings for the upcoming supply year. Hence, if UCAP ratings were to be revised in March to take effect June of that year, the reconfiguration auction could be held in April. This recommendation is based on the premise that one of the principal uses of the reconfiguration auction is to allow for increases and decreases in the UCAP rating of a unit.

As a supplement to the reconfiguration auction, we would also recommend that ISOs periodically qualify resources as eligible substitute capacity. In order to qualify as eligible substitute capacity, capacity would need to meet all normal testing requirements, and meet all credit requirements. This process could be done continuously from the date of the auction until the holding of the reconfiguration auction. For example, if an auction for June 2008 to May 2011 was held in February 2005, the ISO could qualify replacement capacity for June 2008 to May 2009 in July of 2005, February 2006, July 2006, February 2007, July 2007, and February 2008. That qualified capacity would be eligible for the reconfiguration auction for May 2008 to June 2009 and would also be eligible to enter a bilateral arrangement at any time to provide substitute capacity for any auction winner.

NERA considered a further qualification requirement that in order to qualify as substitute capacity, such capacity would have to demonstrate that it was not in a position to bid in the original auction. This would be because of the state of development or uncertainties regarding future viability – e.g., environmental uncertainties. The advantage of this approach is that it discourages withholding from the original auction and encourages more aggressive bidding as it limits second opportunities.

Further, absent such a requirement, there is a gaming opportunity. Specifically, new resources that had no intention of being developed could participate in the auction, appear to set a competitive entry price and then be quickly abandoned and substituted with capacity withheld from the auction. While limiting the participation in reconfiguration auctions to capacity that was unable to participate in the original auction, closes the opportunity, it is overly blunt. Instead, we recommend that the ISOs develop prohibitions against this type of gaming and monitor behavior. For example, new resources bidders would be required to represent they have no agreement to use substitute capacity and financial penalties could be imposed on new resource developers who fail to proceed with development and soon after the centralized auction contract with capacity that was withheld from the auction or use their own existing capacity as a substitute resource.

12.3. Filling Gaps

Gaps occur when the ISO has under contract less capacity than it ultimately needs. A gap could occur for two primary reasons. These are:

- Resource supplies that were in the auction are unable to develop a new plant or demand resource or an existing resource decides to shut down or becomes unable to operate.
- Load grows faster than anticipated and the ISO has not procured resources to cover the unanticipated load growth.

The issues that NERA examined are whether the ISO filling gaps would interfere with the objectives of the reconfiguration auctions or whether filling gaps would have negative implications for the basic CRAM auction.

With respect to gaps that are created by the inability of a generation unit to perform, a key issue is the terms of the capacity contract between the ISO and the resource provider.

One alternative is for the contract to remain in place when an inability to perform becomes evident and allow for the resource provider to acquire qualified substitute capacity. Under this alternative the gap would be filled by the resource provider not the ISO. However, the resource provider would have no incentive to fill the gap at a cost great than the centralized auction clearing plus the deficiency charge that would be surrendered as liquidated damages.

The second alternative would be to have the contract contain clear termination provisions in the event of a demonstrated inability to perform. A demonstrated inability to perform would be a failure to meet a milestone for financial closing, a failure to begin construction, abandonment of construction, destruction of an existing plant, loss of operating permits for an existing plant, and other similar events. The contract would terminate upon these events, deficiency payments would come due as liquidated damages and the ISO's would then assume the right to fill the gap.

NERA believes that the second alternative is preferable when there is a demonstrated inability to perform and substitute capacity has not been procured by the auction winner. The objective of the original CRAM auction is to assure adequate supplies. The deficiency charge recommended by NERA is an incentive to perform and does not guarantee that damages from non-performers will be recouped. Allowing centralized auction winners an open option to fill gaps would weaken the performance incentive and grant an option to those unable to perform. The incentive would be to delay the acquisition of substitute capacity until some savings relative to the deficiency charge can be realized. In contrast, if the ISOs had the right in the case of an inability to perform to immediately terminate, collect liquidated damages and fill gaps, the intent of the original CRAM auction would be preserved.

These provisions would apply to resources that were clearly unable to perform due to physical impairment, loss of operating permits, failure to complete construction or abandonment. The ISO's could fill the gap immediately upon contract termination. Resource providers that acquired substitute capacity before a contract default would not face termination.

Units that suffered a reduced UCAP rating due to increased outages or lower capability, fall in to a different category. These units would realize the diminished ability closer to the beginning of the supply period and would still have a valid contract to supply capacity, but would be unable to fully perform. Further these units may in the future be able to regain the ability to fully perform.

NERA does not recommend that the ISO's procure to fill these gaps caused by reduced UCAP ratings on a forward basis. The shortages caused by these conditions are unlikely to be significant and can be offset by resources that experience an increase in rating or increase in UCAP due to better forced outage experience. A reconfiguration auction held prior to the delivery period should provide a sufficient opportunity for these gaps.

In filling gaps related to resources that were unable to perform, it is again recommended that the ISO's qualify capacity eligible to fill these gaps. Qualifications requirements would be identical to those for substitute capacity. The substitute capacity would be required to meet all development, operational and financial requirements.

In summary with respect to filling gaps, due to the inability of a resource provider to perform, NERA makes the following specific recommendations:

- The contract include provisions that termination occurs upon physical impairment of the facility, failure to meet milestones for financial closing and construction, loss of operating permits or abandonment in the event that substitute capacity has not been procured by the resource provider.
- Upon contract termination, deficiency payment is due to the ISO.
- Upon contract termination, the ISO's procure replacement capacity for a term that extends through the beginning of the commitment period until the end of May of the year preceding the first year of the commitment period for the next auction with a three-year planning horizon. For example, if a default relative to the 2005 auction for the period June 2008 to May 2011 occurred in the summer of 2005, the ISO's would procure replacement capacity for June 2008 to May 2009. The 2006 auction for June 2009 to May 2012 would be increased to volume to account for the fact that some of the capacity from the 2005 auction would not be available as anticipated.
- The qualifications for gap capacity be identical to those for substitute capacity eligible for reconfiguration auctions.
- The price paid to purchase replacement capacity would not impact the original centralized auction clearing price, but would affect the price paid by LSEs to recover ISO costs.
- Gaps related to non-permanent changes in capacity ratings, such as reduction in UCAP as a result of forced outage experience, not be filled through ISO procurement or a forward basis.

Gaps can also occur because the load forecast has increased relative to the original auction. For example, if load is assessed once a year, the ISO's may realize in early 2006 that the volume target for the June 2008 to June 2009 period is greater than the volume target established at the time of the 2005 auction. The ISO′s could elect to fill this gap by a supplemental procurement.

However, it is not clear that this is necessary, nor is it clear that they would not disrupt some of the expectation that bidders had formed with respect to the level of capacity that would be operating during the commitment period and resulting energy and AS net revenues. Historically, integrated utilities always have planned capacity additions with lead times and reliability achieved has not always been exactly the target reliability. NERA recommends that the ISOs only conduct gap procurements for changes in the load forecast when there is a significant unforeseen change in load that would reduce reliability to clearly unacceptable levels. Further, NERA recommends that the ISOs primarily rely on supplemental demand response and real time pricing alternatives to maintain reliability in these situations.

NERA′s scope does not include the specification of method in gap procurements and mitigation methods. We have addressed the gap issue because it is related to reconfiguration auctions. As gap procurement would not have the discipline of entry with a sufficient lead time, we would expect that the ISO′s would need to develop procedures to ensure that prices for resources to fill gaps are reasonable and that filling gaps is cost effective.

One implication of NERA′s recommendation is that the ISO′s purchasing of capacity to fill gaps will compete with auction winners who seek to purchase from qualified substitute capacity for economic reasons as well as to compete with reconfiguration auction winners who have experienced change in ratings and seek to acquire substitute capacity. NERA does not see a problem with this. However, the ISO′s will need to establish clear guidelines for procurement to ensure that the competition is not unfair to resource providers or to sellers of substitute capacity.

12.4. Spot Markets

The issue of a capacity spot market was also not in NERA′s scope. However, NERA addressed this issue during stakeholder meetings. The role of the spot market needs to be considered in light of NERA′s other recommendations. Those are briefly summarized below.

- Three years prior to need the ISO′s will conduct a centralized auction to fill the anticipated need.
- Upon the termination of contract with a winning resource provider, that has not procured substantial capacities, the ISO will fill the gap caused by the termination.
- The ISO′s will assess whether the load forecast has increased, and could procure additional resources from resources if the load increase threatens reliability.

As a result of the above recommendations, there may be spot imbalances. A spot imbalance could arise from the following conditions:

- If at the final reconfiguration auction, providers who are short due to UCAP decreases do not procure sufficient resources to fill the shortage
- Load projections have grown, but the shortage is not serious enough to warrant filling the gap.
- Resources fail during the commitment period – for example a boiler implodes.

Unlike the real time energy market, there is no need for an instantaneous balance between supply and demand in the capacity market. The CRAM is intended to ensure that sufficient resources are developed and maintained in order to provide for resource adequacy. If due to the factors above, the amount of capacity is inadequate on a spot basis, the ISO's could conduct a prompt month resource procurement to induce added supply that had a zero month lead time requirements. However, this market may have no competitive discipline, as there is no assurance that sufficient supply will be available. Opening this spot market to resources that could have participated in the original centralized auction or could have participated in reconfiguration auctions or earlier gap procurements may result in an incentive to bypass those opportunities and sell on a spot basis thereby diminishing competition in all of these auctions. NERA recommends that spot procurement by the ISO's be limited to situations where there is a serious reliability threat, caused for example by the sudden prolonged outage of a large generating unit, and that spot procurement be limited to encouraging the development of short lead time emergency resources and demand response programs that would not normally participate in the original or reconfiguration auctions. The ISO's could evaluate the need for this type of procurement on a case-by-case basis.

NERA does not see any reason or sensible way to implement a general spot market for capacity. Further, we see no purpose to the spot market. The energy spot market is required for real time balancing and also establishes an expectation against which forward energy trades can be made. The CRAM is not designed to hedge against a spot capacity market that serves a real economic function – that is to balance real time supply and demand. Rather the CRAM market is intended to ensure that adequate capacity has initiated development with a sufficient load time. It is the market that serves the economic balancing function between the demand and supply for capacity.

APPENDIX A. THE UNIVERSE OF POSSIBLE AUCTION FORMATS

The auction structures under consideration by the RAM Group include 'Reverse English', 'Descending Clock' and 'Pay-as-Bid' ('Receive-as-Offer') auctions. Unfortunately, in the field of auctions, there is no standard accepted language.[28] For this reason, this introduction provides an explanation of the terminology and sets out the universe of possible auction formats that could potentially be used for ISO capacity auctions. The section is intended to clarify and streamline the discussion.

The auction literature is usually written for the case of selling objects, but all results readily translates into the case of purchase or procurement. In this document, we exclusively use the language of procurement auctions.

The auction literature is organized around the distinction between auctions for a single unit and auctions for multiple units.[29] In the next sections, we follow this structure. We first introduce procurement auctions for a single unit of capacity. We then extend the analysis to the relevant case of auctions for multiple units of capacity.

Basic Concepts from Single Unit Auctions

As recognized in the RP[30], a complete description of an auction fundamentally requires two items:

- a set of bidding rules: how is bidding organized?
- pricing or payment rules: how much do the winners receive?

For auctions of a single object, bidding rules are typically categorized as 'sealed bid' or 'open' auction rules. Open auctions bidding rules can further be split into 'ascending' and 'descending' types. Sealed bid auctions allow two pricing rules: the winner receives what he bid, or he receives what the lowest losing bidder bid. There are therefore four basic auction types for the procurement of one unit. These are best depicted in the following table:

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[28] The report uses the terminology employed in the terms of reference.

[29] A standard introduction is ***Paul Klemperer, "Auction Theory: A Guide To the Literature", in The Economic Theory of Auctions, Elgar Reference Collection, Paul Klemperer (ed), 2000***

[30] Attachment A, point 3

Table A.1

Basic Types of Single Unit Auctions

Sealed bid auctions	***Open auctions***
First price auction (receive-as-offer auctions)	Ascending price auction (reverse Dutch auction)
Second price auction	Descending price auction (reverse English auction)

In a sealed bid auction bidders cannot respond to bids submitted by other bidders. Each bidder submits one sealed bid and the allocation and pricing is based on these bids alone. Therefore, sealed bid auctions are also called 'one shot' or 'closed' auctions. In an open auction bidders can revise their bids and their valuation during the bidding process, as bids are disclosed as they are submitted.

Pricing rules in sealed bid auctions are usually categorized as 'first price' or 'second price' rules. In a first price auction the winning bidder receives a payment equal to his own bid whereas in a second price auction the winning bidder receives a payment equal to the lowest loosing bid, i.e. the second lowest bid. The second price auction is also called a 'Vickrey' auction after William Vickrey who first proposed this auction format in an article in 1961.[31]

In descending auctions (also called reverse English auctions, where 'reverse' refers to the auction being a procurement auction instead of a sale), the price for the object is bid down until one bidder remains. The last person to drop out is the winner and he receives a payment equal to the price at which the auction stopped. Since that price is determined by the lowest losing bidder, the winner pays the 'second price' and a descending auction is therefore also considered to be a second price auction.

In practice, descending price procurement auctions are often implemented as auctions over several rounds where bidders submit bids within some timeframe. Bids and provisional winners are then announced and another round of bidding takes place, until no new bids are submitted. A clock auction, also called a 'Japanese' auction, is another variation of the English auction in which the auctioneer announces the price every round, instead of leaving to the bidders to name the price that they would be willing to accept.

In ascending procurement auctions (also called reverse Dutch auctions, named after flower sale auctions in the Netherlands), the price is gradually increased until the first bid is received and

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[31] Vickrey, W. (1961) "Counterspeculation, Auctions and Competitive Sealed Bid Tenders", Journal of Finance, 16, 8-37

the first bidder wins the object at that price. Since it is the first bid that wins and the price is equal to the bid by the first bidder, this auction is also considered to be a first price auction.

Bidding Strategies Adjust to Auction Rules

At the danger of stating the obvious, bidders can be expected to adjust their bids to both auction mechanisms and pricing rules. For example, in a sealed bid auction in which the winner receives his bid for each unit of capacity, bidders can be expected to submit a higher bid than in a sealed bid auction in which winners receive the bid of the lowest bidding loser.

ISO Capacity Auctions: Auctions of Multiple Units of Capacity

The ISO capacity auctions are auctions of multiple units of capacity where each bidder is allowed to win more than one unit. More auctions types are available for this situation, and the analysis of these auctions is significantly more difficult.[32] Consequently, the literature has been more developed for the simpler case of single unit auctions, and general results are often only available for the single auction type.

Basic Concept of a Supply Schedule

In a multiple unit procurement auction bidders must express their willingness to supply multiple units. In the most simple extension of the single unit auction, bidders submit a single bid which consists of a single price per unit of capacity and a maximum amount of capacity that they would like to win (it is a maximum in case bids are tied). For example (Example 2), bidders submit a price of 80 $/kW-year, and say that they want to win a maximum of 500 MW of capacity.

If the auction is a sealed bid auction, then a significant shortcoming of this bid format is that bidders cannot express decreasing/increasing marginal valuations of multiple units. For example, a bidder may have more than one plant with different costs of capacity. Suppose the bidder has two plants, one of which can produce 300 MW, while the other can produce 200 MWs. Suppose that if the bidder received 80 $/kW-year for the first plant, it would just cover its costs of that plant. However, he would make a loss on the second plant. The bidder would need to receive at least 90 $/kW-year for the second plant. The bidder may therefore wish to submit different prices for the first 300 MW and the last 200 MW of capacity.

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[32] The analysis of multi unit auctions where bidders are allowed to win only one object is essentially identical to the analysis of single unit auctions. For example, if 10 units are for sale, a second price sealed bid auction would allocate the 10 units to the 10 highest bids and all pay a price equal to the 11th highest bid. The increased complexity of multi unit auctions is due the fact that bidders may demand multiple units.

This can be accommodated by submission of what is termed a 'supply schedule' consisting of different bids on different units of capacity. A supply schedule auction is like the simple auction with the added possibility for bidders to submit different prices for their different plants. In our example, the bidder would be allowed to submit a bid of [80 $/kW-year for 300 MW, 90$/kW-year for 200 MW].

Current markets in PJM, NY-ISO and ISO-NE use schedule bidding. In the PJM energy market bidders make offers by submitting linear functions. Supposing that the bidder in our example would be happy to submit offers continuously between 100 MW and 500 MW. Then our figure translated to the PJM energy market format would be: [(100 MW, bid1: 80$/kW-year, slope1: 1), (300 MW, bid2: 90 $/kW-year, slope2: 1)].

For sealed bid auctions, we focus the attention of our analysis to bids expressed as supply schedules. For open auctions, we notice that the need to submit supply schedules does not exist.

General Formats for Multiple Unit Auctions

As with single unit auctions, it is useful to distinguish between sealed bid and open auction formats in the case of multiple units. In this section we present three sealed bid formats of multi unit auctions and their open format counterparts. The following table gives an overview of multi unit auction formats:[33]

Table A.2
Basic Types of Multi Unit Auctions

Sealed bid auctions	***Corresponding open auctions***
Discriminatory auction (Receive-as-offer auction)	Ascending price auction (reverse Dutch auction)
Uniform price auction (Reverse English Auction)	Descending price auction (Clock auction)
Vickrey auction	Ausubel auction

Each sealed bid format has a corresponding open bid format that is outcome equivalent in the sense that if bidders submit the same bids in the two auctions, the outcome (allocation and

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[33] If lots are not identical, still more auction types could be considered, in particular so-called combinatorial auctions.

payment) would be the same.[34] The pricing rules of the six basic multi unit auction types are illustrated below.

Receive-as-offer auction

In a receive-as-offer procurement auction each bidder receives an amount equal to the sum of his bids that are deemed to be winning. That is, the sum of his bids among the k highest bids if k units are procured.[35] This is illustrated in Example 3.

Ascending price auction (reverse Dutch auction)

In the multi unit Dutch procurement auction (or open ascending price auction) the auction starts with a price low enough so that no bidder is willing to supply a unit at that price. The price is then gradually increased until a bidder indicates that he is willing to supply a unit at the current price. This bidder is then winner of one unit at that price and the auction continues. The price is increased until another unit is sold, and so on until all units have been procured.

Example 3
Receive-as-offer Auction and Open Ascending Price Auction

Suppose a total of 500 MW of capacity is available in the auction. Bidder A is willing to bid 100 $/kW-year for the first 100 MW, 105 $/kW-year for the second 100 MW and 115 $/kW-year for the third 100 MW, which can be represented by the following 'supply schedule': [100 $/kW-year: 100 MW, 105 $/kW-year: 100 MW, 115 $kW-year: 100 MW]. Similarly, bidder B has a supply schedule of [90 $/kW-year: 100 MW, 110 $/kW-year: 100 MW, 120 $/kW-year: 100 MW] and bidder C has a supply schedule of [85 $/kW-year: 100 MW, 95 $/kW-year: 100 MW, 110 $/kW-year: 100 MW].

In both auctions, the 500 MW are allocated to the bidders with the five lowest bids, i.e. bidder A wins 200 MW, bidder B wins 100 MW and bidder C wins 200 MW.

Suppose in the receive-as-offer auction bidders submitted the supply schedules specified above. Bidder A receives $100+$105=205 $/kW-year for 200 MW, bidder B receives 90 $/kW-year for 100 MW and bidder C receives $85+$95=180 $/kW-year for 200 MW.

In the open ascending price auction the price is gradually increased until 85 $/kW-year, at which point bidder C accepts 100 MW at the price of 85 $/kW-year. The price is increased further until bidder B accepts 100 MW at a price of 90 $/kW-year. Then bidder C accepts 100 MW at a price of 95

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[34] Bidders may of course choose to submit different bids in two outcome equivalent auctions. For example, when bidders adjust valuations in an open auction, as a response to observed rival bids, the outcomes will differ.

[35] In energy markets, the discriminatory auction is usually called a 'Request for Proposal' or 'RFP'.

$/kW-year, bidder A accepts 100 MW at 100 $/kW-year and another 100 MW at 105 $/kW-year. At this point all five units are sold and the auction stops.

The total cost of procuring the five units is 475 $/kW-year and individual bidders receive the same amount in the two auction formats.

Reverse English auction

A Reverse English auction in the sense of the terms of reference is a sealed bid uniform price auction in which all units are procured at a market-clearing price. All supply schedules bid into the auction is aggregated into a market supply schedule, and the market-clearing price is then determined by the lowest losing bid.[36] All bids lower than this price are winning bids and bidders receive the market-clearing price for all units of capacity supplied.

Clock auction

In a clock auction, the auction starts with a price high enough so that there is excess supply. The price is then lowered gradually and bidders reduce the number of units they are willing to supply. The auction ends at a price that equates supply and the amount of capacity to be procured. Winning bidders are those bidders that remain in the auction at this point, and they receive the same price for all units.

Example 4
Reverse English Auction and Clock Auction

Continued from Example 3

Suppose bidders have the same willingness to supply as in Example 3 above. The 500 MW of capacity are therefore allocated to the same bidders, and only the pricing differs.

In the reverse English auction all bidders pay the same price per units. The price is equal to the lowest losing bid, i.e. the 6th lowest bid, which is 110 $/kW-year. Hence, bidder A receives 220 $/kW-year for 200 MW, bidder B receives 110 $/kW-year for 100 MW and bidder C receives 220 $/kW-year for 200 MW.

In the clock auction the price is gradually decreased until (slightly below) 120 $/kW-year, at which point bidder B reduces his supply from 300 MW to 200 MW. The price is decreased further and at

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[36] Sometimes the market-clearing price is defined as the highest winning bid. Any price between the highest winning bid and the lowest losing bid equates demand and supply.

(slightly below) 115 $/kW-year bidder A also reduces his supply from 300 MW to 200 MW. At (slightly below) 110 $/kW-year both bidder B and C reduce their supply by 100 MW. At this point the total supply is equal to the five lots to be procured and the auction stops. With a price of 110 $/kW-year each bidder receives the same amount as in the reverse English auction.

The total cost of procuring the five lots is 550 $/kW-year and individual bidders receive the same amount in the two auction formats.

Vickrey auction

In a Vickrey auction, a bidder who wins k units receives the k lowest loosing bids of other bidders (i.e. not including his own bids). The winning price of each unit is thus determined by the bid displaced by the winning bid. The winning price therefore reflects the 'opportunity cost' of the bidder's bids, i.e. what the winning bids would have been in a receive-as-offer auction if the bidder had not been there.

Ausubel auction[37]

The Ausubel auction starts with a price high enough so there is excess supply. As the price is reduced, the number of units supplied decreases until the number of units supplied by other bidders is less than demand. At such a price, any bidder who faces a positive 'residual demand' is awarded a unit at that price. The price is reduced gradually until all units have been allocated in this way.

Example 5
Vickrey Auction and Ausubel Auction

Continued from Example 4

In the Vickrey auction the five winning bids are the five lowest bids. However payments to winning bidders are determined by rival bidders' bids in the following way: Bidder A receives the two lowest losing bids among rival bidders, which is $110+$110= 220 $/kW-year. Bidder B receives 110 $/kW-year and bidder C receives $110+$115= 225 $/kW-year.

In the Ausubel auction the price is decreased gradually until some bidder faces a positive residual demand. Residual demand is calculated as demand – supply by other bidders. At an initial high price, i.e. a price above 120 $/kW-year, supply is (300 MW, 300 MW, 300 MW). Residual demand is thus (-100 MW, -100 MW, -100 MW) since demand is 500 MW and supply by other bidders is 600

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[37] L. M. Ausubel, ***An Efficient Ascending Bid Auction for Multiple Objects, (1997), University of Maryland Working Paper***

0, 1).

Price = 115, Demand = 5

MW, for all 3 bidders. This is illustrated in the table below:

Price > 120, Demand = 5

Bidder	Valuations	Supply	Residual
A	(100 $/kW-year: 100 MW, 105 $/kW-year: 100 MW, 115 $/kW-	300 MW	-100 MW
B	(90 $/kW-year: 100 MW, 110 $/kW-year: 100 MW, 120 $/kW-year:	300 MW	-100 MW
C	(85 $/kW-year: 100 MW, 95 $/kW-year: 100 MW, 110 $/kW-year:	300 MW	-100 MW

At a price just below 120 $/kW-year bidder B reduces supply by 100 MW. Supply is then (3, 2, 3) and with a demand of 500 MW residual demand is (0, -1, 0).

Price = 120, Demand = 5

Bidder	Valuations	Supply	Residual demand
A	(100, 105)	2	2
B	(90)	1	1
C	(95)	1	1

Bidder A is awarded 200 MW, bidder B 100 MW and bidder C 100 MW, all at a price of 110 $/kW-year. At this point all 500 MW are sold and the auction stops.

The total cost of procuring the 500 MW is 555 $/kW-year and individual bidders receive the same amount in the two auction formats.

The examples above showed that when bidders submit the same supply schedule in all auctions, their payment differs. The discriminatory auction yielded at total payment of 475 $/kW-year, the uniform price auction yielded a payment of 550 $/kW-year and the Vickrey auction yielded a payment of 555 $/kW-year. However, as we have already noted in section 5.2.1, bidders would adjust their bidding strategies depending on the pricing rule.

A large part of auction theory is concerned with the impact on bidding behavior that is induced by the pricing rule. In a discriminatory procurement auction bidders have an incentive to increase bids because each bid determines the payment. In a uniform price auction, bidders also have an incentive to increase bids, but only on marginal units, which may turn out to be pivotal in price determination. Finally, bidders do not have incentives to distort bidding in the Vickrey auction as no bid determines the payment received by the corresponding bidder. With these remarks in mind, the ranking of payments in the three examples above should be less surprising.

The basic auction formats for multi unit auctions outlined above are generalizations of the basic single unit auction formats. The receive-as-offer auction corresponds to a first price auction and both the clock auction and the Vickrey auction reduce to second price auctions in the case of a single unit. In the single unit clock auction, the auction stops at the point at which the lowest losing bidder drops out. This is the price of the single unit Vickrey auction.

However, with multiple units there is an important difference between clock auctions and Vickrey auctions. A property of second price auction is that bidders cannot gain from misrepresenting their true supply schedule. This is due to the fact that the payment received does not depend on the bid amount. In a uniform price auction for multiple units, a bid for the last unit a bidder wins may determine the price of all units he wins. Therefore, the proper generalization of a second price auction to a multiple unit auction is an auction format where no bid will determine the payment received by the bidder who submitted that bid. The Vickrey auction (or the outcome equivalent open format, the Ausubel auction) has this property.

Sequential Auctions

One further issue, which is present only when multiple units are procured, is the choice of simultaneous or sequential auction. In a simultaneous auction all units are procured in the same auction. In a sequential auction one or more of the units will be allocated in a first auction, which is then followed by a second, third, etc. auction that allocate one or more units until all units have been allocated. In a sequential auction, each auction in the sequence will of course be subject to the same design questions as a simultaneous auction. In addition, there are some issues that arise because of the sequential structure of auctions. Since the sequential structure of the capacity auctions is a prime concern for the ISOs, a separate section is devoted to this problem.

APPENDIX B. AUCTION TYPES THAT APPEAR UNSUITABLE FOR CRAM

Sequential Auctions for Unit after Unit

In this section a sequential auction means an auction format where one unit is auctioned after the other within one day, or a small time interval. For example, with around 70,000 MW of capacity in PJM there would be 700,000 units of capacity of 100 kW each. Every one of the units would be sold in a separate auction. This means that bidders have information about price and allocation of one unit before bidding on another.

In a later section we will discuss staggered auctions, where procurement is spread out over longer periods, such as a year or two years, and procurement for different commitment periods may be overlapping. In addition to the sequential revelation of information on price and allocation, staggered auctions imply that also uncertainty that is external to the bidders (e.g. forecast of price in energy market) varies over the sequence of auctions.[38]

While we will deal with the issue of staggering in section 4, we think that sequential auctions in which one unit of capacity is sold after another within a short period of time should be ruled out. In general, selling off units sequentially complicates the bidding problem that bidders face. They need to decide not only the price which they bid for every unit, but also whether they should bid in the first, second, third…etc. auction or whether they should vary prices across auctions. Auction theory remains inconclusive regarding the price path that could be expected for the units from auction to the next. While the theoretical literature would expect on average constant, or declining, prices, the empirical literature often points towards increasing prices over time.[39]

A further issue is the problem of splitting the bidding into units that do not correspond to the sizes of plants. In this way a so-called exposure problem may be created, in which a bidder that won a unit in an early auction needs to win another unit in a later auction to ensure profitable operation.

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[38] As defined in this section, staggered auctions may involve a sequence of sequential or simultaneous auctions. The question of sequential or simultaneous auction is thus part of the auction format design problem whereas staggering relates to the broader context of each individual auction.

[39] Weber, R. (1983): "Multiple Object Auctions", in R. Engelbrecht-Wiggans, M. Shubik and R. Stark (eds.), ***Auctions, Bidding and Contracting: Uses and Theory***, pp. 165-191; Ashenfelter,). (1989): "How Auctions Work for Wine and Art", ***Journal of Economic Perspectives***, 3, pp. 23-36

It seems unnecessary to expose bidders to these difficult bidding problems by running auctions sequentially and we believe that sequential auctions for every unit should therefore be ruled out.

Simple Sealed Bid Auctions

In the introduction to the different auction formats we assumed that bidders were allowed to submit bids in the form of a supply schedule. In other words, bidders were allowed to express their marginal valuation of different units. In a simpler auction format bidders are restricted to submit a single bid, which is a bid per unit for all units up to some maximum number of units the bidder is willing to supply. Essentially, this is like restricting bidders to submit a horizontal supply schedule. Therefore, the simple format does not allow bidders to express their true preferences/costs.

Such an auction would appear to represent an unnecessary restriction on the preferences of bidders and we would therefore rule out this auction type.

Vickrey Auctions and Ausubel Auctions

Vickrey auctions, and their open format counterpart Ausubel auctions, are rarely used in practice. There are several reasons for this.[40,41]

Value revelation

If all bidders are rational, then, in a Vickrey auction bidders reveal their true costs since it is a dominant strategy to bid the true costs. A truth revealing strategy may give away valuable information to competitors. It could reveal a firms precise costs to potential competitors with whom the firm subsequently negotiates. In contrast, in a uniform price auction, bidders only observe the drop out prices of non-winners. This was illustrated in our Example 4 and Example 5. The information that is revealed in the auction in Example 3 (the uniform price auctions) is much smaller than the information revealed in the Vickrey / Ausubel auctions of Example 4.

Possibility of Different Prices for Same Bids

In Vickrey and Ausubel auctions, the price paid on one unit may depend on 'irrelevant' (more accurately: non-winning) bids. For example, consider that two objects are available and two bidders bid the following supply schedules: Bidder A bids [4,6] and bidder B bids [4,7]. In this

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[40] Rothkopf, Teisberg and Kahn (1990) "Why are Vickrey Auctions Rare?" ***Journal of Political Economy***, vol.98, no.1, 94-109.

[41] Lucking-Reiley, D. (2000) "Vickrey Auctions in Practice: From Nineteenth-Century Philately to Twenty-First-Century E-Commerce" Journal of Economic Perspectives, Vol.14, no.3, 183-192.

case bidder A receives one unit at a price of 7 while B receives one unit at a price of 6. Both bidders receive one unit, they have the same valuation of one unit, and they submit the same bid for the first unit, but bidder B pays more. This may be perceived as 'unfair' (although it is not).

Lack of experience

The lack of experience with Vickrey auctions in practice may hinder its use. This is in contrast to the other auction types, variants of which have been used successfully throughout many industries.

Experimental evidence on overbidding in single-unit Vickrey Auctions

In a single-unit Vickrey auction each bidder ought to submit a bid that is equal to his valuation of the object. In particular, submitting a bid that is higher than the valuation can never be profitable, as it will only increase the probability of winning the object when the price is above the valuation. Similarly, submitting a bid that is below the valuation will only decrease the probability of winning the object when winning is profitable. Moreover, the strategy of bidding the true valuation is independent of other bidders' bidding strategies. Therefore, there are good reasons to believe that bidders would follow this strategy. However, it has been observed in experiments that bidders bid higher than their valuations in a Vickrey auction.

Also, when valuations are independent, an English auction is strategically equivalent to a Vickrey auction in the sense that each bidder will find it optimal to keep bidding until the price reaches his valuation. Based on the strategic equivalence between the two auction formats, one would expect to see similar bidding behavior. This equivalence has also been rejected in experiments.

Kagel, Harstad and Levin (1987)[42] have conducted a series of experiments on bidding behavior in Vickrey- and English auctions. They found that prices averaged 11% above valuations in Vickrey auctions. This result has been replicated with both experienced and inexperienced bidders by Harstad (1990)[43] and Kagel and Levin (1993).[44] For example, Kagel and Levin observed in a Vickrey auction that 30% bid their valuation, 62% bid above their valuation, and 8% bid below valuations. For comparison Kagel and Levin also conducted similar experiments

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[42] Kagel, Harstad and Levin (1987) "Information impact and allocation rules in auctions with affiliated private values: A laboratory study", ***Econometrica*** 55, 1275-1304.

[43] Harstad (1990) "Dominant strategy adoption, efficiency and bidders' experience with pricing rules", memo.

[44] Kagel and Levin (1993) "Independent private value auctions: Bidder behavior in first-, second- and third-price auctions with varying numbers of bidders", ***Economic Journal*** 103, 868-879.

using English auctions and found that there was essentially no difference between valuations and bids after few rounds of auctions.

Overbidding in Vickrey auctions by some bidders will generally lead to less efficient allocations, in the sense that the objects auctioned off are not allocated to the bidders with the highest valuations. 82% of the first-price auctions and 79% of the Vickrey auctions reported by Kagel and Levin were efficient. The frequency of efficient outcomes in Vickrey auctions was thus comparable to first-price auctions, although for different reasons. First-price auctions are known to produce inefficient allocations when bidders are asymmetric, even with experienced and fully rational bidders. The inefficiency observed in the Vickrey auctions is due to errors by bidders. In any case, the experimental evidence suggests that English auctions would more likely yield an efficient allocation.

It is difficult to justify the observed bidding behavior in Vickrey auctions, but one explanation that is often suggested is the following: If bidders overbid in an English auction and win the object, they will always end up paying too much for the object. On the other hand, in a Vickrey auction, bidders can overbid and win, and still receive the object at a price below the valuation (this case will occur when the second highest bid is below the winning bidder's valuation). The punishment for overbidding is thus much more transparent in the English auction. In other words, the simplicity of the English auction, where bidders only have to accept/reject the current price, seems to facilitate an efficient outcome as theory predicts. The overbidding may be a problem similar to the lottery playing problem: in lotteries, usually the total payout is only a fraction of the sum of the ticket sales. This means that everyone loses in expectation, even if they are risk neutral. Yet there is ample evidence that millions of people play these 'unfair' games. If other factors outside of one's valuation need to be taken into account in the bidding behavior in Vickrey auctions, then that auction format loses its raison d'être by failing to break the link between bid and payment.

Experimental evidence on bidding behavior in multi-unit auctions

Kagel et al (2002)[45] have studied three alternative versions of multi-unit auctions where sincere bidding is optimal, i.e. it is optimal to bid the true valuation. The three auction formats are a Vickrey auction and two versions of an Ausubel auction: with and without dropout information.

The Ausubel auction with dropout information generated outcomes closest to sincere bidding and higher efficiency than the other two auction formats. Similar to the results from single-unit experiments, deviations from sincere bidding in the Vickrey auction largely resulted from

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[45] Kagel, Kinross and Levin (2002) "Comparing Efficient Multi-Object Auction Institutions", working paper.

overbidding. In contrast, inefficiencies in the Ausubel auction without dropout information largely resulted from bidders dropping out too soon, i.e. a form of underbidding. The overall conclusion is that the Ausubel auction performs better than Vickrey, but only when dropout information is provided.

At a more general level these experiments suggest that an open auction format, where bidders accept/reject a posted price, perform better than a sealed bid auction. It is important to stress that this result is not due to value discovery in the open auction format, as when valuations are affiliated. The experiments were conducted in an environment where bidders were endowed with independent private valuations. In this environment, optimal bidding strategies in for example Vickrey- and Ausubel auctions are equivalent. Nevertheless, observed bidding differed, which can only be ascribed to irrational behavior by bidders. With this in mind, practical auction design should lean towards 'simple' auction formats. Apparently it is 'simpler' to accept a range of posted prices than submitting a bid equal to the highest price you would accept.

Another issue, related to the simplicity of an auction, is the 'robustness' of the equilibrium concept. In first-price auctions, for example, the optimal bidding strategy for any given bidder assumes that other bidders follow the same equilibrium strategy. If this is not the case, and some bidders deviate by misinterpreting the situation, the theoretical literature on auctions is largely silent about the implications. The predictions of auction theory rely on bidders being perfectly rational and following equilibrium strategies. Even more difficulties arise in auctions that have multiple equilibria and bidders have to predict which equilibrium is being played. In this case, even perfectly rational bidders who understand the auction mechanism could end up bidding according to different equilibrium strategies. These difficulties should be contrasted with second-price auctions, where the optimal strategy, i.e. bidding the true valuation, is an optimal bidding strategy regardless of other bidders' strategies. In this sense, the equilibrium concept underlying the second-price auction is more robust since each bidder's optimal bid does not depend on expectations about other bidder's strategies.

Considerations that need to be made before choosing an auction format

After excluding some auction formats, four formats remain: Discriminatory Auction and Uniform Price auction, and their two corresponding open formats, reverse Dutch and reverse English. The choice is thus between an open or closed format and between discriminatory or uniform pricing.

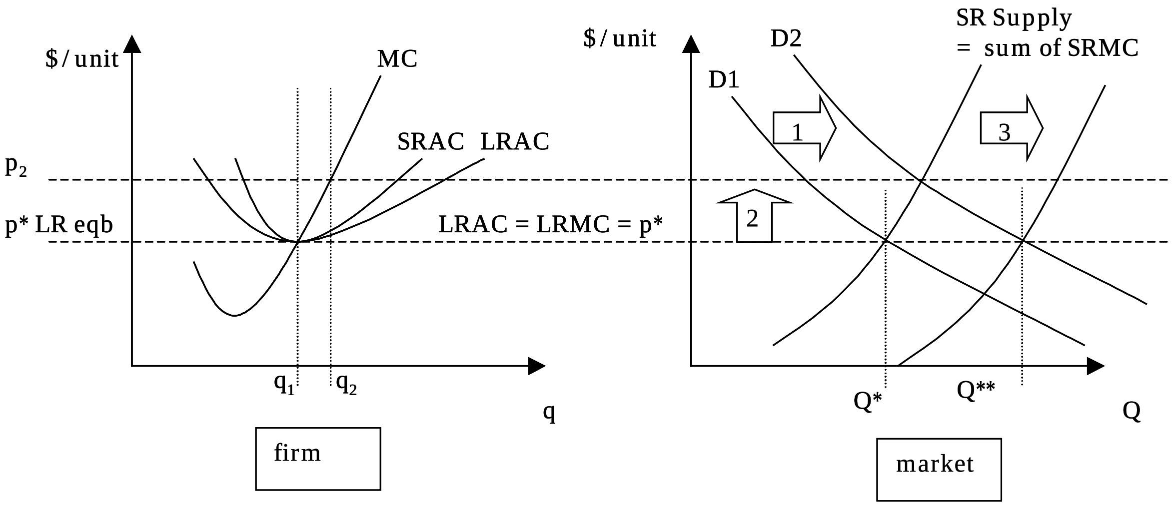
We note that the auction formats specifically mentioned in the terms of reference are amongst those. We will consider those two auction types in detail and add comments on the additional two auction formats that we have identified as potentially suitable.

We remind the reader that we will focus the investigation on the relationship between the capacity auction and the existing energy market in the supply period (Appendix D), the resolution of demand uncertainty (section 5.3.1), the resolution of individual bidder's uncertainty over who is the least cost producer (section 5.3.2), the benefits of adding an additional market (section 5.3.3), and the ability of an auction to solve the problem of co-coordinating entry (section 5.3.4).

APPENDIX C. LONG RUN COMPETITIVE DYNAMICS IN A GENERIC MARKET

This section illustrates the dynamics of entry and exit in a generic market. In a competitive market that is in long run equilibrium, there is no entry or exit. By definition, profits are zero and there is no incentive for entry or for exit. Entry occurs in a competitive market only if the market is not in long-run equilibrium, only if there is a temporary imbalance that creates positive economic profits. These economic profits can arise because demand increases, because cost decreases, or because firms exit as equipment becomes obsolete. The following is a description of the competitive mechanism for the case of a demand increase in a generic market. All other changes in the market that would create positive profits and induce entry would involve similar mechanics.

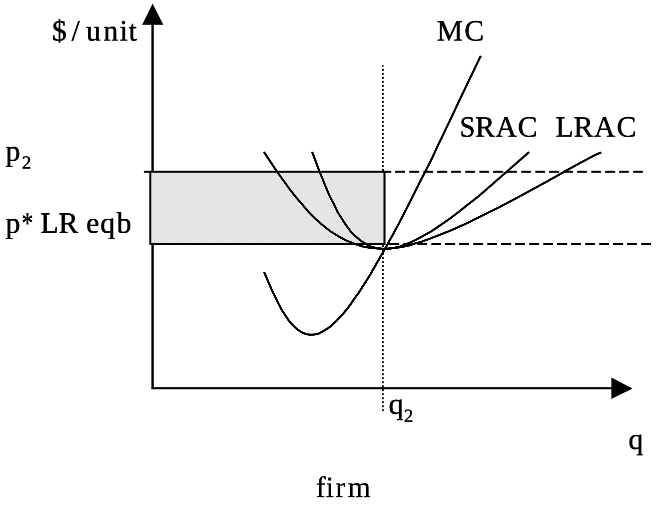
Figure C-1
A Market Equilibrium Changing Due to an Increase in Demand



In this generic market, the industry is initially at a long equilibrium. The marginal firm produces q_1. The market is in equilibrium with the quantity traded being Q* and the price being p*. This long run equilibrium price is equal both to the LRMC of the firm and to the minimum of the LRAC. Price is equal to marginal cost since each firm is acting as a price-taker and maximizing profits. As the price is also equal to average cost of the marginal firm, the marginal firm is making zero economic profit and there is no incentive for entry or exit.

In this illustration, the long-run equilibrium is disturbed by an increase in demand (arrow 1). The number of firms is fixed in the short run because there is insufficient time to build or expand. The increase in demand moves the industry to a new short run equilibrium. The market price rises to p_2 (arrow 2) and as a result, firms in the market increase the quantities they produce. Price is equal to marginal cost so that each firm is maximizing profit as a price taker. In the market as a whole, the new equilibrium is on the original supply curve because the number of firms is unchanged. At these levels of output, price is above average cost and firms make positive economic profits as illustrated in the figure below.

Figure C-2
A Market with Positive Profits



In the long run, as time becomes sufficient to build and to expand, new firms are attracted by the profit opportunity and enter the market. The increase in the number of firms increases the supply in the market (arrow 3 in the previous figure), which induces the market price to fall. The number of firms increases until there is no incentive for further entry, which means that the price in the market has returned to the level of the long run average cost of the marginal firm. The quantity in the industry has expanded compared to the initial long run equilibrium and the marginal firm is again making zero economic profits.

The illustration of the long-run competitive dynamics in a generic market is stylized and heavily simplified. The long-run competitive dynamics in the energy market – absent a capacity market and other markets – are both more complicated and subtle, but the basic lessons are nevertheless sound.

APPENDIX D. THEORETICAL OVERVIEW OF THE RELATIONSHIP BETWEEN THE ENERGY AND CAPACITY MARKETS

The relationship between the capacity auction and the energy market in the commitment period is complex. In order to clarify the relationship between the capacity auctions and the energy market, we present a simplified model of an energy market where there is a capacity procurement auction followed by a spot energy market. The intention is to gain some insight on the decision problem facing bidders in the capacity auction. Before doing so, however, we describe the institutional set-up of the other markets available to participants in each ISO.

Broadly speaking, the ISOs operate a combination of:

- Day-ahead / real-time spot markets;
- Ancillary service markets;
- Markets / Charges related to Transmission Congestion;
- Out-of-merit orders and other peak-load regulation measures;
- Demand response programs; and
- Price caps.

For the consideration of the capacity auction, the ancillary service markets, demand response programs and out-of-merit orders are important in that they are attempts to ensure reliability of the grid in times of peak demand. In this way, they affect the profitability of new capacity, which is also determined under peak demand conditions.

The two goals of network reliability and market pricing under peak conditions are in natural conflict with each other. Measures to address the balance between the two continue to evolve. Indeed, the capacity auction can be seen as a way to move some of the reward for the construction of new capacity away from peak hours and to spread it over more hours of generation. In this sense ancillary market services will be required less often with the introduction of a capacity auction.

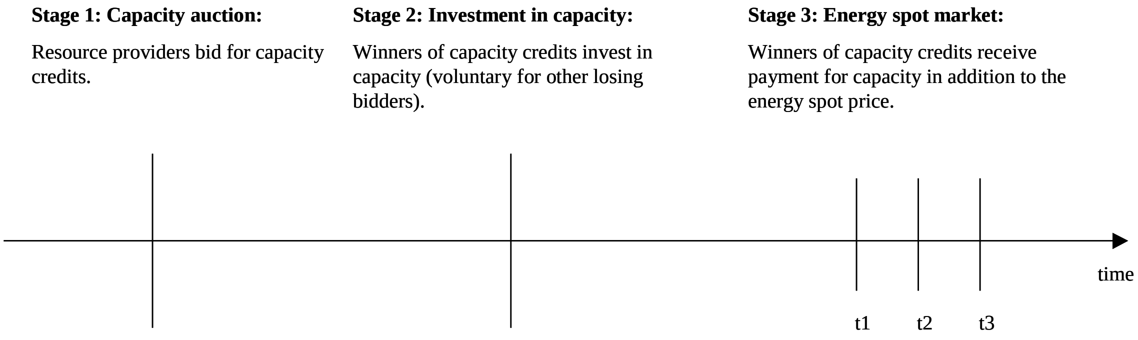
Likewise, demand response programs are evolving and administrative measures at peak times, such as out-of-merit orders, are being redesigned to make them fit with a market based approach. Such redesign necessarily presents bidders in a long-term capacity auction with additional uncertainty (which may be termed ‘regulatory uncertainty’). Bidders in the capacity auction need to estimate the profitability of their capacity investments over a time horizon of more than three years. In the course of the three years until the new capacity comes on-stream, market regulations for the peak energy markets might have evolved in ways that could materially affect the profitability of the new capacity unit.

Since the proposed capacity auction interacts with the peak markets and administrative measures to ensure reliability under peak conditions, bidding behavior in the capacity auction will be closely linked to how the energy markets are expected to operate at those times. For the design of the auction, it is therefore of great importance to understand in depth how the relationship between the capacity auction and the energy market affects bidding behavior. For this purpose we have designed a simplified model of the business decision of a resource provider.

Benchmark model of capacity auction

This section outlines a simple model of an energy market where capacity is procured in a capacity auction. The structure of the model is as follows: At stage 1, capacity is procured in a capacity auction. We denote the price of capacity by p^c. At stage 2, investment in capacity takes place. All resource providers who are winners of the capacity auction have an obligation to invest in capacity since, for the moment, we assume there is no installed capacity in the market. However, investment in capacity is voluntary for a bidder who does not win in the capacity auction. At stage 3, the commitment period, resource providers bid in the energy market. In practice, the energy market is a series of daily markets but here we will represent the energy market by three periods, with different demand conditions. We denote the price of energy by p^e. This model will serve as a benchmark for the discussion that follows. Figure D-1 illustrates the timing of events in this model.

Figure D-1
Timeline for Capacity / Energy Model



Stage 1: Capacity auction:

Resource providers bid for capacity credits.

Stage 2: Investment in capacity:

Winners of capacity credits invest in capacity (voluntary for other losing bidders).

Stage 3: Energy spot market:

Winners of capacity credits receive payment for capacity in addition to the energy spot price.

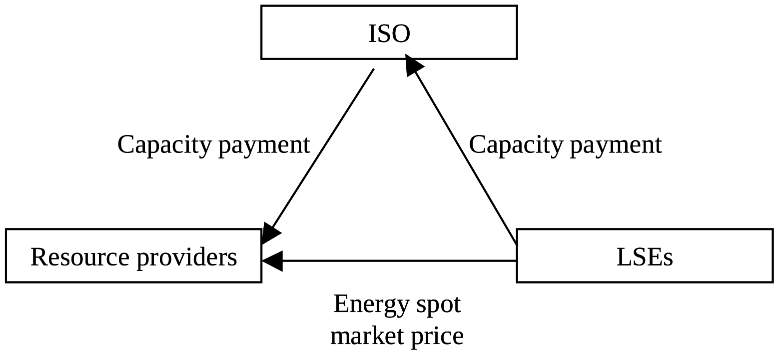
We assume that resource providers are of identical size but they may have different costs of capacity. Capacity can be installed at a fixed cost of f^i per unit for bidder ***i***. Each resource provider decides whether to enter a bid of one single unit of capacity in the capacity auction. Bidders have perfect information about own and rival bidders′ costs as well as demand conditions in the energy market. By definition, production of one unit of energy at a point in time requires one unit of capacity.

Example

Suppose there is only one standard power plant available and it has an output of 1,000 MW. The costs of installing and operating the 1,000 MW plant are different for everyone. Bidders and the ISO know that the average demand in the commitment period will be 30,000 MW. The capacity procured in the capacity auction, corresponding to the minimum capacity requirement of 116.67% of average demand, is therefore 35,000 MW.

Energy production can be undertaken at a constant cost c^i for each bidder.

Figure D-2
Payment streams in the Capacity / Energy Model



Winners of the capacity auction receive one third of p^e from the ISO at the time that each of the energy market takes place, i.e. the total capacity payment over the commitment period is p^e.

Stage 3: Energy Market

In order to abstract from demand side complexities in the energy market, we suppose that it is run as a centralized market over three trading periods t1, t2 and t3. Energy demand is a fixed quantity in each trading period. For convenience we assume that each period lasts for the same number of hours. The trading periods should be understood to represent one peak-demand period (period t3) and two off-peak demand periods (period t1 and t2). For the same reasons of simplification of bidding strategies as in the capacity auction, we assume the price of energy p_t^e is determined in a uniform price auction.

As we discussed in the introduction to the model, market mitigation measures such as price caps, out-of-merit orders and other regulation market activities occur when demand is at its peak. The reason is that the reliability of the energy flow is most endangered at peak times. Additionally, not enough price signals are filtered through from the wholesale market to the final consumers. Final consumers usually do not have contracts that vary with wholesale pricing. Therefore they cannot be expected to respond to higher wholesale prices by reducing their demand. Their demand is 'inelastic'.

With an inelastic, i.e. vertical, demand curve we can represent mitigation measures as an upper limit on the price of energy, i.e. a reserve price in the energy auction.[46] The limit on the price can be interpreted as a price cap imposed by the ISO, and the implication is that when there is excess demand in the energy auction, the price of energy is bounded by this cap, $\overline{p^e}$.

At the time of the energy market, capacity investments are sunk. Existing total capacity in the energy market determines the price of energy. Resource providers do not take into account their sunk costs when bidding in the energy market. Without a capacity auction, such bidding behavior can lead to losses for all the bidders, if market mitigation measures exist. The consequence would be that not enough investment in new capacity or in the maintenance of existing capacity would be undertaken.

Bids to supply capacity are aggregated into a supply function and the price all winners receive is equal to the lowest loosing bid.

Example contd.

Suppose the commitment period is one year and that three energy spot markets are held throughout the year. Also, suppose the energy demand in the commitment period (all three trading periods together) is 262.8m MWh, i.e. all yearly hours run at the average level of capacity of 30,000 MW. The energy demand is decomposed into two off-peak periods and one peak-period. Each period is 2,920 hrs long. In the peak period, all 35,000 MW of capacity is used and therefore demand is 102.2m MWh. In each of the off-peak periods, only 27,500 MW of capacity is used and demand is therefore 80.3m MWh.

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[46] Otherwise the price in the energy auction would be infinite in periods of excess demand.

Stage 2: Investment decision

The capacity auction has procured an amount of capacity that is just sufficient to cover demand, and winners of the capacity auction have to make this investment. Losers of the capacity auction can thus anticipate that if they invest there will be excess capacity in the energy market, in which case the price of energy will be $p^e = c$. With no profit in the energy market, losers of the capacity auction will choose not to invest in capacity since they would make a loss of $-f$ if they do invest in capacity.

Stage 1: Capacity Auction

In order to concentrate on the relationship between the capacity auction and the energy market, we assume that bidders bid competitively and are unable to manipulate the price that they receive in the capacity auction. We achieve this simplification by supposing that the auction is run as a uniform price auction (where the price is determined by the lowest loosing bid) and by assuming that each bidder can only supply one unit of capacity. As explained in Appendix D, in this type of auction, bidders can be expected to bid their true costs regardless of their estimates of other bidders′ bids. While this is a technical detail, it guarantees that the bids in the capacity auction are competitive.

Recall that in order to focus on the relationship between pricing in the capacity auction and pricing in the energy market we make the simplifying assumption that each bidder can only supply one unit of capacity/energy. This assumption is more innocuous than one might suspect. Indeed, the assumption is analogous to assuming that bidders supplying multiple unit of capacity/energy do not take into account the fact that a bid submitted for one MW may affect the price of another unit. Instead, bidders submit bids on each single unit as if they were single unit bidders. Consequently, the auction rules of the capacity auction and the energy auction will not be at the forefront of the analysis. In addition, as stated previously, by assuming that each auction is a uniform price auction, bidders do not have incentives to misrepresent demand in any one auction. Any inefficiencies or price distortions that may arise in the following analysis are thus due to the institutional setup and the relationship between the capacity auction and the energy market.

Example contd.

Suppose that 40 bidders submit bids in the capacity auction for a total of 40,000 MW of capacity. Recall that total demand in the capacity auction is equal to 35,000 MW. The bids are received by the auctioneer and aggregated into a supply function. They are stacked from lowest to highest. Suppose the bids are [1st: $25/kW-year, 2nd: $26/kW-year, 3rd: $26.5/kW-year, …, 35th: $49/kW-year, 36th: $50/kW-year, ….,40th: $59/kW-year]. Then the

1st to the 35th bid would be winners and all bidders would receive a capacity payment p^c equal to the 36th bid, that is, $50/kW-year. With this pricing rule, no bidders have incentives to distort their bids since they can't affect the clearing-price.

At the price of $50/kW-year each bidder with a 1,000 MW plant receives $50m. The total transactions value of the capacity auction is 35 * $50m or $1.75 billion.

In Table D.1 we list all the possible outcomes for each bidder. Bidders can either win or loose in the capacity- and energy auctions. We assume that all the resource providers that supply off-peak energy also supply peak-energy. Moreover, losers in the capacity auction can choose not to invest in capacity, in which case they cannot participate in the energy auction.

Table D.1
Payoff under different outcomes of the capacity auction and the energy market

Stage 1: Capacity auction	***Stage 2: Investment decision***	***Stage 3: Energy market***	***Profit***	
Win	Invest	Win 'peak' + 'off-peak'	$-f^i + p^e$	$p^e_{t1} - c^i + p^e_{t2} - c^i + p^e_{t3} - c^i$
		Win 'peak' only	$-f^i + p^e$	$p^e_{t3} - c^i$
		Lose	$-f^i + p^e$	0
Lose	Don't invest	Cannot participate	0	0

Example contd.

Suppose a resource provider wins 1,000 MW of capacity credits in the capacity auction. The resource provider's capacity costs are $40/kW-year or $40m for the plant of 1,000 MW. Therefore the net payoff to the resource provider out of the capacity auction is equal to $50m-$40m = $10m.

In the energy market, suppose that the resource provider has marginal costs of energy production of 2.95 cents/kWh. His plant is used for 1,000 hours in off-peak periods and for all 1,500 hours in the peak period. The market-clearing price is 3 cents/kWh in off-peak periods and 4 cents/kWh in the peak period. The resource provider's net payoff from the energy market is therefore equal to 0.05 cents/kWh * 1,000h * 1,000 MW = $0.5m in each off-peak period and 1.05 cents/kWh * 1,500h * 1,000 MW = $15.75m in the peak period.

The total net profit to the resource provider from the capacity auction and the energy market is therefore equal to $26.75m.

Summary of pricing

Bidders in the capacity auction anticipate that total capacity will be equal to demand in the energy market. Bidders can therefore earn a positive profit equal to $\overline{p^e} - c$ in the energy market, and they are willing to supply capacity below the level of fixed costs. With a price cap some of the cost recovery is shifted to the capacity auction.

Suppose, for illustration purposes, that there is no capacity auction and the full cost of capacity must be recovered in the energy market. We continue to use three periods of energy markets. In two out of three energy market periods there is excess supply. In periods with excess supply, the price of energy is competed down to marginal costs of the lowest losing bidder, i.e. $p_{t1}^e = p_{t2}^e = c$. In periods with excess demand, the price of energy is bounded by the price cap, i.e. $p_{t3}^e = \overline{p^e}$ and this price is below the market clearing price. The payment streams without a capacity auction are illustrated in Table D.2.

Table D.2
Payments without a capacity auction

	Cost of capacity	Energy payment	Cost of energy
Investment stage	$-f$		
Period t1		p_{t1}^e	$-c$
Period t2		p_{t2}^e	$-c$
Period t3		$\overline{p^e}$	$-c$

Without a capacity auction, the profit of the most inefficient energy producer is therefore $-f + \overline{p^e} - c$, which is negative since the price cap is binding, since it restricts the price from reaching the level that would make that sum just equal to zero. The cost of capacity is f and the only net revenue in the energy market is in the period with excess demand, where the energy producer earns $\overline{p^e} - c$. Consequently, there would be insufficient investment in capacity.

With a capacity auction, energy prices would be $p^e = c$ in periods with excess supply and $p^e = \overline{p^e}$ in periods with excess demand, as without a capacity auction. However, the capacity auction assures each energy producer a total payment for capacity, which is $p^c = f - (\overline{p^e} - c)$. The payment streams with a capacity auction are illustrated in Table D.3.

Table D.3
Payments with a capacity auction

	Cost of capacity	Capacity payment	Energy payment	Cost of energy
Investment stage	$-f^i$			
Period t1		$(f^i - (\overline{p^e} - c))/3$	p^e_{t1}	$-c^i$
Period t2		$(f^i - (\overline{p^e} - c))/3$	p^e_{t2}	$-c^i$
Period t3		$(f^i - (\overline{p^e} - c))/3$	$\overline{p^e}$	$-c^i$

With a capacity auction, the profit of the marginal resource provider is thus zero. The capacity payment in each period allows each energy producer to break even. The capacity auction is therefore a way to address the problem of covering fixed costs, thereby ensuring the reliability of the energy system at peak times.

Without a price cap and without a capacity auction, there would be high price spikes in periods of excess demand. Investment incentives would not be distorted in this case. The price cap reduces the incentive to invest in capacity since high price spikes are not allowed. The capacity auction secures the same payment, but spread out over all periods, and thus restores incentives to invest.

Example contd.

The resource provider would make a loss of $23.25m without a capacity payment. Recall, that the net profit from the energy market alone was $16.75m ($0.5m + $0.5m + $15.75m) and the cost of the 1,000 MW plant was $40m. Therefore, this particular resource provider requires a price of $23.25/kW-year in the capacity auction in order to enter the market and break even. A price of $23.25/kW-year yields a total capacity payment of $23.25m for a 1,000 MW plant, or $7.75m in each of the three periods.

Demand uncertainty

The previous section assumed that bidders had complete knowledge about other bidders' costs as well as demand conditions. Suppose instead there is uncertainty about the number of hours that are at peak demand. In other words, at the time of the capacity auction, it is unknown to the bidders how many hours are in period t1, t2 or t3. Bidding in the capacity auction and investment decisions must thus be made using the expected value of the energy price. We know from the analysis above that the energy price is equal to the price cap when there is excess demand and that the energy price is equal to the marginal cost of the marginal producer when there is excess capacity. Let θ denote the probability of excess demand. The expected price of energy is then $E(p^e) = q\ \overline{p^e} + (1-q)c$ and the price in the capacity auction will be bid down to $p^c = f - q(\overline{p^e} - c)$. Hence, demand uncertainty implies a larger price in the capacity auction (compared to demand certainty). Moreover, if the ISO decides to 'play safe' and procure an amount of capacity that will cover demand in most cases (i.e. low probability of excess demand) the price in the capacity auction will be close to the cost of building capacity.

It should also be noted that if the demand uncertainty is resolved after capacity auction but before trade in energy market, there is an option value of not winning in the capacity auction and postponing the investment decision. For example, if the price in the capacity auction is zero, winners in the capacity auction would be worse off than losers. Winners would have to invest in capacity and supply the energy market, whereas losers would have the option to wait for more demand information. In this case the price in capacity auction would contain a premium for giving up this option value.

For example, a resource provider that does not win in the capacity auction can choose to invest in capacity at any time between the capacity auction and the time of the energy market. Moreover, the resource provider can choose to export energy to LSE's in other regions. In contrast, a resource provider that wins in the capacity auction has to invest in capacity and supply energy to the home ISO.

Implications for auction design

The relationship between the capacity auction and the energy market is rather complex. We produced a model and an example in order to investigate different aspects of the relationship. It appears that the capacity auction is essentially changing peak-hour revenues from the energy market into a capacity payment that is spread over the whole supply period. One of the fundamental problems the capacity auction should address is that an energy market with various mitigation measures does not allow for adequate remuneration of peak capacity. This implies that investment in such capacity is inadequate and the capacity auction addresses this problem by supplementing energy market revenues with capacity payments. The effect is that even with limited volatility of energy market prices, due to various mitigation measures, resource providers will be compensated as if no energy market measures were in place. In particular, the model illustrated that a tight price cap would be 'offset' by higher capacity payments.

In the light of this model, ancillary services can be seen as a form of price cap in the energy market. Essentially, ancillary services imply that the outcome of the energy market is not completely determined by market forces. For example, when bidders are forced to make capacity available at a given price, they make a loss compared to a completely liberal energy market. Bidders would be compensated, via capacity payment, for this kind of regulation in the same way as they would be compensated for a tight price cap. To the extent that the capacity auction will succeed in limiting shortage of capacity, the need for ancillary services will also be limited.

The model also showed that bidding behavior in the capacity auction depends significantly on the factors that influence the expected energy prices over the supply period. In particular, bidding behavior in the capacity auction will be influenced by factors such as the size and impact of mitigation measures (e.g. price caps); the uncertainty regarding future mitigation measures; and the uncertainty regarding the number of peak-hours in the commitment period. These characteristics would, in the terms of auction theory, all be described as ‘common value characteristics’, and one would want to choose an auction format that assists bidders in addressing the common value uncertainty, i.e. an auction format that allows expectations to be updated throughout the bidding process. In particular, the descending clock auction assists bidders in addressing the common value uncertainty.

APPENDIX E. ABSTRACTS OF REVIEWED LITERATURE ON AUCTIONS

Article	Contents
Ashenfelter, O. (1989) "How Auctions Work for Wine and Art", Journal of Economic Perspectives, 3, 23-36.	Empirical study of sequential auctions where declining prices for identical lots are observed, i.e. 'the declining price anomaly'.
Avery, C. and T. Hendershott (2000) "Bundling and Optimal Auctions of Multiple Products", Review of Economic Studies 67, 483-497.	The optimal auction problem of multiple objects, with particular attention given to the issue of bundling.
Black, J. and de Meza, D. (1992) "Systematic Price Divergences Between Successive Auctions are no Anomaly", ***Journal of Economics and Management Strategy***, 1, 607-628.	Explains declining prices in sequential auctions, as observed by Ashenfelter (1989), by noting that the auctions involved a buyer's option, whereby the first-round winner could purchase further items at the same price.
Creti, A. and N. Fabra "Capacity Markets for Electricity" memo.	Analysis of wholesale electricity markets based on the PJM market design. Having a capacity market demands higher capacity payment in an oligopolistic market than in a monopolistic market.
Engelbrecht-Wiggans, R. (1994) "Sequential Auctions of Stochastically Equivalent Objects", ***Economics Letters*** 44, 87-90	In sequential auctions prices will on average have a downward trend. There are two effects that pull in opposite directions. The more objects that remain in the sequence, the more opportunities to win later auctions, and the less each bidder should bid in early auctions. On the other hand, early winners may drop out of the auction, so remaining bidders face less competition on later auctions. In this paper the latter effect dominates, hence expected revenue is declining over the auction sequence.
Gale and Hausch (1994) "Bottom Fishing and Declining Prices in Sequential Auctions", ***Games and Economic Behavior*** 7, 318-331	Studies standard sequential auctions where the seller chooses the order of sale, and right-to-choose auctions where the winner chooses his preferred item. The right-to-choose format is efficient, the standard sequential auction is inefficient.
Gale and Stegeman (2001) „Sequential Auctions of Endogenously Valued Objects", ***Games and Economic Behavior*** 36, 74-103	Sequential auctions with completely informed bidders. Valuations depend on the final allocation of all items (e.g. synergies). Result: Declining prices over the auction sequence.
Gale, Hausch and Stegeman (2000) „Sequential Procurement Auctions with Subcontracting", ***International Economic***	Procurement auction where subcontracting between sellers is possible after the auction. Sellers can be worse off than when subcontracting is impossible. This is

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Review 41, 989-1020	partly because, with subcontracting, bidders can divest themselves of costly marginal units, which makes bidding more aggressive.
Hausch, D. (1986) "Multi-Object Auctions: Sequential vs. Simultaneous Sales", Management Science Vol. 32, No. 12, 1599-1612.	A seller can choose to sell multiple objects through sequential or simultaneous auctions. Under sequential auctions, bids announced between sales convey information about the value of objects to be sold later, which increases the seller's expected revenue (linkage principle). On the other hand, revelation of information between sales introduces an incentive to underbid in early auctions. As the number of objects is increased the seller is more likely to prefer sequential sales, i.e. the information effect dominates the deception effect.
Luton, R. and R. McAfee (1986) "Sequential Procurement Auctions", Journal of Public Economics 31, 181-195.	An optimal sequence of auctions involves discrimination against the winner of the first auction in later auctions. Winning the first auction in a sequence is a signal of comparative advantage, and so one expects to see the bidder win more often in future auctions. Revenue is increased when the first winner faces a higher reserve price (or pay a participation fee) compared to other bidders.
McAdams, D. (2002) "Modifying the Uniform-Price Auction to Eliminate 'Collusive-Seeming' Equilibria", memo.	Collusive equilibria are eliminated if a small amount of cash is split among rationed bidders! Also, when the auctioneer can vary the quantity after receiving bids, collusive equilibria are eliminated.
McAfee, P. and D. Vincent (1993) "The Price Decline Anomaly", Journal of Economic Theory 60, 191-212	Explains the declining price anomaly by risk aversion. Early bids are equal to expected later prices plus a risk premium associated with the risky future price.
Milgrom, P. and R. Weber (1982) "A Theory of Auctions and Competitive Bidding", Econometrica, Vol. 50, 5, 1089-1122.	An auctioneer can raise the expected revenue by reducing uncertainty about the value of the object he sells. Expected revenue is thus inversely related to the risk faced by bidders. This is a quite general result known as the "linkage principle" (the greater the linkage between a bidder's own information and how he perceives others will bid, the greater the expected price paid upon winning).
Ortega Reichert, A. (1968) "A Sequential Game with Information Flow", in Klemperer (ed) ***The Economic Theory of Auctions.***	Sequential auction where bidders update information and bidding based on competitors' past bidding strategies. Common value uncertainty. Main result: Bidders distort bidding in order to alter opponents' belief about the common uncertainty.
Robert, J (1999) "Sequential Auctions with Multi-Unit Demand: Theory, Experiments	Experimental evidence of declining prices in sequential auctions.

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and Simulations", Mimeo, Université de Montreal	
Von der Fehr, N-H. M. And C. Riis (1999) "Option Values in Sequential Markets", memo, University of Oslo.	Sequential auctions. When a bidder receives one item, his and other bidders' valuations for the remaining items change. Winning the first item has an option value in addition to the stand-alone value of the item. Usually, declining prices emerge.
Weber, R. (1983) "Multi-Object Auctions", in Klemperer (ed) The Economic Theory of Auctions.	When bidders only demand one object and they are risk neutral, expected prices over a sequence of auctions are constant.
Vickrey, W., Counterspeculation, Auctions and Competitive Sealed Tenders, ***Journal of Finance*** 16 (1961), pp. 8-37.	This classic paper introduces not only the Vickrey-auction for the single-unit case, but also a Vickrey-auction for the multi-unit case. When considering sealed bid formats for multi-unit auctions, one should thus have at least three alternatives in mind: the discriminatory auction, the uniform-price auction, and the Vickrey-auction. Like in the other formats, bids in Vickrey's multi-unit auction are supply-functions and units are allocated to the suppliers bidding the lowest price. The difference between the Vickrey-auction and other auctions is in the rule by which payments are determined: A supplier who supplies ***k*** units receives what the supplier would have to pay if he wanted to procure these units from the other suppliers.
Ausubel, L. (1997) "An Efficient Ascending-Bid Auction for Multiple Objects, memo, University of Maryland.	This paper describes an open-bid implementation of Vickrey's multi-unit auction. When considering open-bid formats for multi-unit auctions, one should thus have not only the Dutch and the English Auctions, but also Ausubel's auction in mind. In Ausubel's format, the auctioneer starts with a high price, and then gradually lowers it as long as there is excess supply. Suppose we have reached a price ***p*** at which the total supply of all sellers except one, say seller A, falls short of the buyer's demand by exactly one unit. Then it is clear that seller A will ultimately have to supply at least one unit to the buyer. At this point, in Ausubel's terminology, the supplier "clinches" a unit. He receives for this unit the price ***p*** at which it became clear that A would have to supply this one unit. The demand, and bidder A's supply, are then reduced by one unit, and the auction continues.
Ausubel, L. and Peter Cramton, "Demand Reduction and Inefficiency in Multi-Unit Auctions", discussion paper, University of	For the uniform price auction this paper studies equilibrium bidding strategies. The main theme is that bidders have an incentive to shade their bids (upwards,

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Maryland, July 2002 (first version: November 1995).	in the case of a procurement auction) on all except the first units for which they bid. In other words, the supply functions submitted to the auction will indicate less supply than the true supply curve would. The purpose of this manipulation is to raise the price. Large bidders have particularly strong incentives to do this. A consequence is inefficiency of the auction. In particular, large bidders will lose out to small bidders even though the large bidders would be more efficient, because they will have shaded their bids more. The paper also briefly considers discriminatory price auctions. In such auctions there is no incentive try to manipulate the auction to raise the market price, but, as in single-unit first price auctions, as soon as bidders are known to be heterogeneous, their incentives to shade their bids differ, and more efficient bidders might lose out to less efficient bidders because they have shaded their bids more. In Vickrey’s multi-unit auction it is optimal to bid one’s true demand. Thus, Vickrey’s multi-unit auction, unlike the uniform-price and the discriminatory auction achieves efficiency.
Noussair, C. “Equilibria in a Multi-Object Uniform Price Sealed Bid Auction with Multi-Unit Demands”, ***Economic Theory*** 5 (1995), 337-351. Engelbrecht-Wiggans, R. and Charles Kahn, “Multi-Unit Auctions with Uniform Prices”, ***Economic Theory*** 12 (1998), 227-258. Klemperer, P. and Margaret Meyer, “Supply Function Equilibria in Oligopoly Under Uncertainty”, ***Econometrica*** 57 (1989), 1243-1277. Binmore, K. and Joseph Swierzbinski, “Treasury Auctions: Uniform or Discriminatory”, ***Review of Economic Design*** 5 (2000), 387-410.	These papers study uniform-price auctions in the case in which bidders’ characteristics are common knowledge among bidders, that is, in the case of complete information. The papers highlight that in this case the uniform price auction has large numbers of equilibria. Intuitively, the reason for this multiplicity is that bids for prices other than the (predictable) equilibrium price do not have any payoff consequences for bidders, and can therefore be arbitrary. Binmore and Swierzbinski emphasize that this makes a certain type of implicit collusion possible: Equilibria with a high equilibrium price can be sustained because bidders’ submit supply functions that are very inelastic at the equilibrium price. Then any attempt by one of the bidders to gain more quantity by raising supply will lead to a sharp price drop, and will thus be deterred. Klemperer and Meyer show how equilibrium can become unique if uncertainty about demand is introduced. In their model, this uncertainty prevails at the time at which bidders submit their bids, but is resolved when the auction outcome is determined. Note that this uncertainty is very different from the incomplete information assumed in most auction models.

Article	Contents
Engelbrecht-Wiggans, R. and Charles Kahn, "Multi-Unit Pay-Your-Bid Auctions with Variable Rewards", G***ames and Economic Behavior,*** 23 (1998), 25-42.	This paper investigates for a very special case the equilibria of discriminatory auctions. It finds that with positive probability bidders will shade their bids so that the bids for several units are identical, whereas, in fact, of course, marginal valuations are decreasing. Thus, they will pretend that their supply was ***more*** price-elastic than it actually is. This seems vaguely related to a simple heuristic for bidding strategies in a discriminatory auction: "try to guess the equilibrium price, and then pretend that your marginal costs for all units up to the equilibrium quantity are equal to the equilibrium price".
Krishna, V. and Motty Perry, "Efficient Mechanism Design", discussion paper, Pennsylvania State University and Hebrew University, May 2000.	This paper shows extends the "revenue equivalence principle" to the multi-unit setting. It needs to be carefully noted what exactly the authors mean by the "revenue equivalence principle". It is the result that the expected revenue from an equilibrium of an auction depends only on the allocation rule implied by that equilibrium, and on the expected utility of one bidder type. It needs to be noted that in the single-unit setting, if bidders are ex ante symmetric, standard auction formats all imply the same allocation rule, and therefore the "revenue equivalence principle" implies that standard formats all yield the same expected revenue. That is not true in the multi-unit setting, because in the multi-unit setting standard auction formats imply different allocation rules. Krishna and Perry show for the multi-unit setting that the Vickrey auction maximizes expected revenue among all auctions that implement the efficient allocation rule.
Ausubel, L. and Peter Cramton, "The Optimality of Being Efficient", discussion paper, University of Maryland, June 1999.	This paper extends Myerson's celebrated analysis of expected revenue maximizing auctions from the single-unit case to the multi-unit case. As in the single-unit case, none of the standard auction formats is expected revenue maximizing, unless special assumptions are made. If bidders are ex ante symmetric, and if further assumptions are satisfied, then an auction which allocates units efficiently, if at all, is expected revenue maximizing. Thus, a Vickrey auction with appropriately chosen reserve price is expected revenue maximizing.
Perry, M. and Philip Reny, "On the Failure of the Linkage Principle in Multi-Unit Auctions", ***Econometrica*** 67 (1999), 885-890.	This paper shows that an important result of the theory of single-unit auctions with interdependent values, the ***linkage principle***, does not extend to the case of multi-unit auctions. Roughly speaking, the linkage principle says in a symmetric set-up expected revenue from an auction is

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	higher if the winning bidder's payment, conditional on his bid, is more closely linked to this bidder's private information. The linkage principle is used to show for the single-unit case that the English auction yields higher expected revenue than the Vickrey auction, and that the release of public information prior to the auction raises the seller's expected revenue. Perry and Reny show that the linkage principle does not hold in the multi-unit case, and that therefore one should not expect the mentioned results to extend to the multi-unit case.
Krishna, V. and Robert Rosenthal, Simultaneous Auctions with Synergies, ***Games and Economic Behavior*** 17 (1996), 1-31.	Krishna and Rosenthal consider a very special model of multi-object auctions in which some bidders are interested in only one object, but other bidders are interested in two objects and have increasing marginal valuations for these objects. They consider a private value model. The auction format is that simultaneous, sealed-bid first or second price auctions are conducted for the two objects. The bidders with increasing marginal valuations face an exposure problem: They might get stuck with too few objects, and then can't realize synergies. Equilibrium strategies will take this risk. Krishna and Rosenthal show that bidders with high valuations tend to overbid in each auction whereas bidders with low valuations tend to underbid.
Branco, F. On the Superiority of the Multiple Round Ascending Bid Auction, ***Economics Letters*** 70 (2001), 187-194. Albano, G., Fabrizio Germano, and Stefano Lovo, A Comparison of Standard Multi-Unit Auctions with Synergies, ***Economics Letters*** 71 (2001), 55-60.	Branco, and Albano et. al. consider cases in which simultaneous, English auctions are conducted. Branco finds that the simultaneous English auction leads to more efficiency, and higher expected revenue. Albano et. al. present a case in which the simultaneous English auction leads to more efficiency, but less expected revenue for the seller.
Rosenthal, R. and Ruqu Wang, Simultaneous Auctions with Synergies and Common Values, ***Games and Economic Behavior*** 17 (1996), 32-55. Szentes, B. and Robert Rosenthal, Three-Object, Two-Bidder Simultaneous Auctions: Chopsticks and Tetrahedra, ***Games and Economic Behavior*** 44 (2003), 114-133.	These two papers study further examples of auctions with increasing marginal valuations. The settings are extremely special. Rosenthal and Wang have a common value setting, and Szentes and Rosenthal have a complete information setting. Both papers characterize equilibria in randomized strategies.

Article	Contents
Branco, F. Multi-Object Auctions: On the Use of Combinational Bids, Portuguese Catholic University, 1997. Branco, F. Multi-Object Auctions with Synergies, discussion paper, Portuguese Catholic University, 1997. Levin, J. An Optimal Auction for Complements, ***Games and Economic Behavior*** 18 (1997), 176-192.	These papers study auctions of identical objects that maximize expected revenues if bidders have increasing marginal values. They are ordered in increasing generality. The first paper by Branco finds a case in which a second price auction, which allows combinatorial bids, is expected revenue maximizing. The subsequent two papers show that in general the expected revenue maximizing auction is none of the standard auction formats. However, some form of combinatorial bids always plays a role.
Katzman, B. A Two Stage Sequential Auction With Multi-Unit Demands, ***Journal of Economic Theory*** 86 (1999), 77-99.	Two identical objects are sold in two successive second-price auctions. Bidders have diminishing marginal values. This paper derives equilibrium strategies in a symmetric private-value model. The equilibrium leads to an efficient allocation, and predicts an expected upward trend in prices. For a very special parameterization he also finds that the sequence of second-price auctions yields higher expected revenues than the sealed-bid uniform price auction.
Brusco, S. and Giuseppe Lopomo, Collusion via Signalling in Simultaneous Ascending Bid Auctions with Heterogeneous Objects, with and without Complementarities, ***Review-of-Economic-Studies*** 69 (2002), 407-436.	This paper describes implicitly collusive equilibria of multi-unit auctions where the units are heterogeneous. However, it's message might be relevant here, too. In an open ascending auction Bidders can collude by dividing the objects among themselves in the early rounds, and then cease bidding. This is supported by the threatening of regular (non-collusive) equilibrium bidding in case someone deviates.
Burkart, M. Initial Shareholding and Overbidding in Takeover Contests, ***Journal of Finance*** 50 (1995), 1491-1515.	This paper considers takeover contests where one of the bidders has a toehold in the target company. Such a bidder benefits from a high price, even if he doesn't win the takeover battle. Bidders with toeholds are therefore willing to overbid their true value in an English auction. They bid particularly aggressively. This might be relevant here because capacity suppliers which are simultaneously load servers benefit from a low clearing price, and might therefore bid aggressively. Burkart's paper is only the first in a longer sequence of papers on this issue in the takeover context.
Kagel, Kinross and Levin (2002) "Comparing Efficient Multi-Object Auction Institutions", WP.	Kagel et al have studied three alternative versions of multi-unit auctions where sincere bidding is optimal. The three auction formats are a Vickrey auction and two versions of an Ausubel auction: with and without dropout information. The overall conclusion is that the Ausubel auction performs better than Vickrey, but only

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	when dropout information is provided.

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Kagel, Harstad and Levin (1987) "Information impact and allocation rules in auctions with affiliated private values: A laboratory study", ***Econometrica*** 55, 1275-1304.	Kagel et al have conducted a series of experiments on bidding behavior in Vickrey and English auctions. They found that prices averaged 11% above valuations in Vickrey auctions.
Harstad (1990) "Dominant strategy adoption, efficiency and bidders' experience with pricing rules", memo.	Harstad has replicated the observation of overbidding in Vickrey auctions, see Kagel et al (1987).
Kagel and Levin (1993) "Independent private value auctions: Bidder behavior in first-, second- and third-price auctions with varying numbers of bidders", ***Economic Journal*** 103, 868-879.	Kagel and Levin observed in a Vickrey auction that 30% bid their valuation, 62% bid above their valuation, and 8% bid below valuations. For comparison Kagel and Levin also conducted similar experiments using English auctions and found that there was essentially no difference between valuations and bids after few rounds of auctions.
Rothkopf, Teisberg and Kahn (1990) "Why are Vickrey Auctions Rare?", ***Journal of Political Economy***, vol. 98, 94-109.	Argues that Vickrey auctions are rare for a variety of reasons, especially disincentives for bidders to follow truth-revealing strategies. E.g. due to post-auction interaction between bidders in other markets.
Lucking-Reiley (2000) "Vickrey Auctions in Practice: From Nineteenth-Century Philately to Twenty-First-Century E-Commerce", ***Journal of Economic Perspectives***, vol. 14, 183-192.	Discusses the equivalence between English- and Vickrey auctions. Argues that Vickrey auctions have actually been used more often than generally believed.
Paul Klemperer, "Auction Theory: A Guide To the Literature", in ***The Economic Theory of Auctions***, Elgar Reference Collection, Paul Klemperer (ed), 2000.	This paper surveys the theoretical literature on auctions. It also gives a non-technical introduction to many of the issues that arise in practical auction design.
Marco LiCalzi and Alessandro Pavan, "Tilting the Supply Schedule to Enhance Competition in Uniform-Price Auctions", Northwestern University Working Paper, 2002.	Illustrates how competition can be enhanced by bidding against a supply curve rather than bidding for a fixed quantity. Incentives of supply reduction in uniform price auctions can be reduced this way.
Garcia-Diaz, A. And P. Marin (2003) "Strategic bidding in electricity pools with short-lived bids: an application to the Spanish market", ***International Journal of Industrial Organization*** 21, 201-222.	On collusive equilibria in uniform price auctions, applied to the Spanish electricity market. Discrete bids (rather than continuous bids) reduce the set of collusive equilibria.
M. Magill and M. Quinzii (1996), ***Theory of Incomplete Markets***, MIT Press	--
Special issue of the Journal of Economic Theory (1995), eds. D. Duffie and R. Rahi	--
Menezes and Monteiro (1999) "Synergies and price trends in sequential auctions",	Shows that sequential auctions of complementary objects imply a declining price profile over the auction

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working paper.	sequence.
Feng and Chatterjee (2002) "One auction or two: simultaneous vs. sequential sales in multi-unit auctions", working paper.	Studies the issue of simultaneous vs. sequential auctions, which largely depends on the market structure. When the market is less competitive, the auctioneer can earn more from selling sequentially.
Klemperer (2002) "What really matters in auction design", ***Journal of Economic Perspectives***	A paper that focuses on the lessons learned from the European UMTS auctions. The main message is that collusion in auctions is an important practical issue. Also, auctions should be designed such that they attract a large number of bidders.
Maskin and Riley (2000) "Asymmetric auctions" ***Review of Economic Studies***, 67, 413-438.	Shows that in the presence of asymmetric bidders, the first price sealed bid auction is generally not efficient (may allocate the object to the low-valuation bidder). Therefore, with efficiency concerns as the objective of the auction, the presence of value asymmetries between bidders is a strong argument for the use of open auctions.
Maskin and Riley (2000) "Equilibrium in sealed high bid auctions", ***Review of Economic Studies***, 67, 439-454.	
Jehiel & Moldovanu (2001), "The European UMTS/IMT-2000 License Auctions", working paper.	Surveys the European UMTS auctions using a model that emphasizes the future market structure as a determinant of valuations. A crucial role is played by the relationship between the number of incumbents and the number of licenses.
Jehiel & Moldovanu (2000) "License Auctions and Market Structure", working paper.	
Vanderporten (1992) "Strategic behavior in pooled condominium auctions" Journal of Urban Economics, 31, 123-137.	Documents the declining price effect in sequential auctions of condominiums.
Ashenfelter and Graddy (2002) "Art auctions: a survey of empirical studies", working paper	Reviews a large number of empirical papers on bidding behavior in auctions. The paper reveals a large number of irregularities in bidding behavior, which is poorly explained in the received literature on auctions.
Thurston (2002) "Sequential Auctions: Theory and Evidence from the Seattle Fur Exchange", working paper.	Documents the declining price effect in sequential auctions of fur. Offers an explanation of buyer heterogeneity.