Outage substitution capacity pool auction:
A theoretical framework

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Outline

- Revisit the problem statement
- The proposed auction
  - Walk through theory
    - Nash equilibria
    - Procurement auction theory
  - Walk through three examples
- Considerations and summary

ISO Goals

- Design an outage substitution process that is:
  - Economically efficient
  - Reliable process for buyers and sellers, and CAISO
  - Incents showing of resources

DMM proposes an **auction mechanism** to **reduce search** and **coordination problems** with finding substitute RA capacity for planned outages.

The auction mechanism is called a **reverse second price auction**.

DMM proposal

- Design an auction mechanism that is:
  - Economically efficient
  - Reliable process for buyers and sellers, and CAISO
  - Incents showing of resources
  - Addresses market power concerns
  - Considers strategic interactions between market participants

- Nash equilibria: *a situation where no participant could gain by changing their own strategy.*
  - These equilibria are theoretically economically efficient

NASH EQUILIBRIA

Nash equilibria

A situation where no participant could gain by changing their own strategy.

- Properties of auctions with Nash equilibria:
  - **Predictability**: When bidders follow strategies that lead to a Nash equilibrium, the auction outcomes become more predictable. This helps both the ISO and the market participants to make informed decisions.
  - **Fairness**: Nash equilibrium ensures that no bidder can benefit by unilaterally changing their strategy, leading to a fairer competition where each bidder's strategy is optimal given the strategies of others.
  - ***Price formation:*** Certain auction designs, like the second-price auction, can lead to Nash equilibria that maximize the seller's revenue.* Bidders are incentivized to bid their true values, ensuring the item is sold at a price reflecting its true market value.
  - **Efficiency**: Auctions designed to reach Nash equilibrium can allocate resources more efficiently. The item being auctioned is more likely to go to the bidder who values it the most, leading to an optimal allocation of resources.
  - **Simplicity**: In some auction formats, like the second-price auction, the strategy leading to Nash equilibrium is straightforward (bidding one's true value). This simplicity can encourage participation and reduce the complexity of decision-making for bidders.

*DMM highlights this is less a property of the *reverse* second price auction

Nash equilibria

A situation where no participant could gain by changing their own strategy.

The assurance game

- Suppose you and your partner are deciding to make or order pizza…

A pizza game	Player 2: Make it	Player 2: Order it
Player 1: Make it	**(3, 3)**	(0, 2)
Player 1: Order it	(2, 0)	**(2, 2)**

- The non-Nash strategies are: one partner makes the pizza and they lose their utility, while for the other it's as-if they ordered it.

- Nash equilibria
  - Both partners make pizza together: This is a cooperative equilibrium where both players receive a higher payoff (3, 3). It represents mutual cooperation and trust.
  - Both partners order out together: This is a risk-dominant equilibrium where both players receive a lower payoff (2, 2). It represents a safer, but less rewarding, strategy.
- This is similar to the Prisoners Dilemma

- This Nash concept can be extended to a multiple participant space through auctions
  - Bidding *reservation* prices is the pay-off in games like this scenario, and leads to the optimal payoff outcome (if designed correctly).

REVERSE SECOND PRICE AUCTIONS

Reverse second price auction mechanics

- **Reverse:** the roles of the buyers and sellers are reversed compared to a traditional auction, i.e. it's the buyers that need the good, and the sellers are the ones bidding to provide the good
  - The *buyer* is the market participant *planning an outage*, and the *seller* is the *provider of the substitution capacity*
- **Second price** auction: the clearing bid price is the price second to last clearing price. In the case of a reverse auction, it is the next bid price – examples later.
- **Auction** *(sequential clearing)*: (1) the highest bidding buyer enters the auction, and the single auction clears. (2) The market repeats until the prices or quantities of bids cannot support any further transactions. The final "second price" is the price that clears the last available MW(s), and is applied to all transactions.
  - The auction is conceptually similar to a repeated eBay auction.

Reverse second price auction mechanics

- Why use **second prices** in an auction?
  - The auction is **not** setting marginal prices, it elicits the willingness to trade goods as if you were in a bilateral market with the added benefits of market thickness of additional buyers and sellers.
  - The prices in the auction are **reservation prices**, **not marginal prices**.
    - *Reservation price*: The maximum price a buyer is willing to pay for a good or service, or the minimum price a seller is willing to accept.
    - *Marginal price*: The price of producing one additional unit of a good. In this setting, nothing additional is produced.
  - The second price has improved price formation properties, and leads to a Nash equilibrium with its beneficial properties.

~~Reverse~~ second price auction example

- eBay, as a starting point:

- Seller (in 1995):
  - Reservation price $80
- Buyers
  - Buyer 1: $50
  - Buyer 2: $85
  - Buyer 3: $100
- Solution:
  - Sells for $85 to buyer 3

~~Reverse~~ second price auction example
Bidders: Alice ($50) and Bob ($40)

- **First-Price Auction:**
  - In a first-price auction, the highest bidder wins and pays the amount they bid.
- **Alice's Strategy:** Alice values the item at $50. If she bids her true value ($50), she risks overpaying. So, Alice may bid slightly lower than $50 to increase her surplus (the difference between her value and the price she pays).
  - Alice might bid $45 to win, but this way she wins the auction and pays $45, leaving her with $5 surplus ($50 value - $45 bid).
- **Bob's Strategy:** Bob knows his value is $40, but to have a chance to win he might bid higher (at $44), thinking this would give him a better chance than bidding $40.
- **Result**: Alice wins, pays $45, and has a surplus of $5, while Bob has a surplus of $0 (since he didn't win).
  - Alice and Bob didn't reveal their true values as a result of the first-price auction incentives.
  - Strategic bidding instead of true value bidding.

- **Second-Price Auction:**
  - In a second-price auction, the highest bidder wins but pays the second-highest bid.
- **Alice's Strategy:** Alice knows that she values the item at $50, and in a second-price auction, she can bid her true value without fear of overpaying. Even if Alice bids $50, she only pays the second-highest bid (Bob's bid), which might be $40.
- **Bob's Strategy:** Bob knows his value is $40, and if he bids his true value, he will never win since Alice's bid will always be higher. Bob may still bid his true value of $40, as he knows that in the second-price auction, if he wins, he pays the second-highest bid (which will be lower than $40).
- **Result**: Alice wins with a bid of $50, but pays Bob's $40 bid. Alice's surplus is $10 ($50 value - $40 price), and Bob's surplus is $0 (since he didn't win).
  - True values are revealed to the auction.

~~Reverse~~ second price auction

Why the Second-Price Auction is Superior:

- **Incentive to Bid Truthfully:** In a second-price auction, both Alice and Bob have an incentive to bid their true values. Alice knows she will only pay the second-highest bid, which allows her to bid $50 and still guarantee a surplus of $10.
  - In the first-price auction, Alice is incentivized to bid below her true value to avoid overpaying. She bid $45 instead of $50, resulting in a lower surplus of $5.
  - Bob overbid in hopes he may still win, but bid exceeding his true value.
- **Efficiency:** The second-price auction leads to more efficient outcomes where the item goes to the bidder who values it most, and the price paid is lower than in a first-price auction. Alice, who values the item at $50, wins and pays $40, which is closer to the true value, rather than the $45 she might have paid in the first-price auction.
- **Simplicity and Predictability:** The second-price auction reduces strategic complexity for bidders because they can simply bid their true value, whereas in a first-price auction, bidders must calculate how much to adjust their bid to avoid overpaying, which can lead to inefficient outcomes.

Reverse second price auction example

A toy example for the outage substitution pool

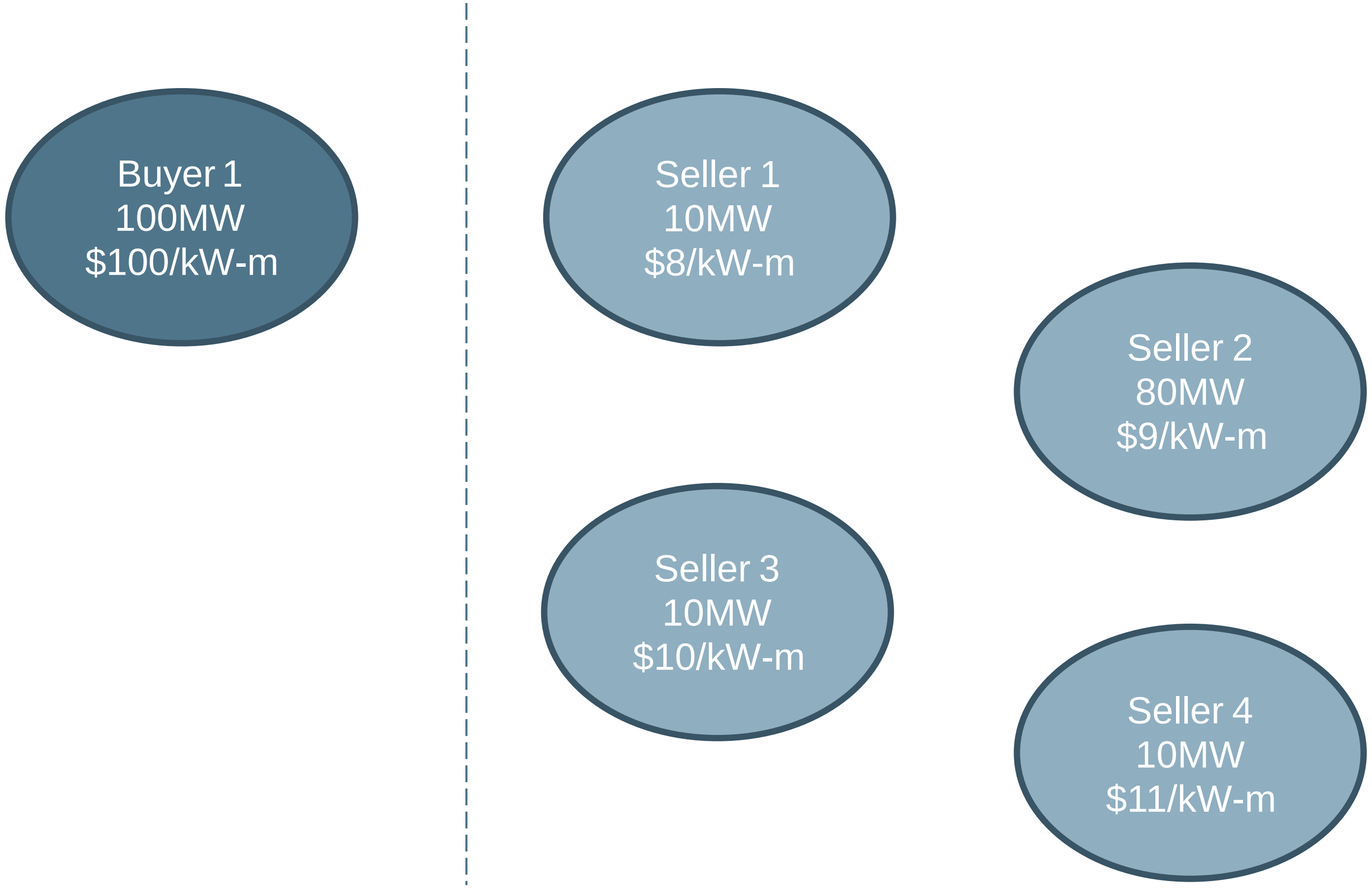
- Suppose a market with three (hopeful) buyers and eight sellers.

- We are going to walk through:
  - A reverse auction
  - The second price
  - The sequential market clearing logic

- This is called a “sealed bid” auction, where no information is revealed before the auction is run.

Reverse second price auction example

A toy example for the outage substitution pool

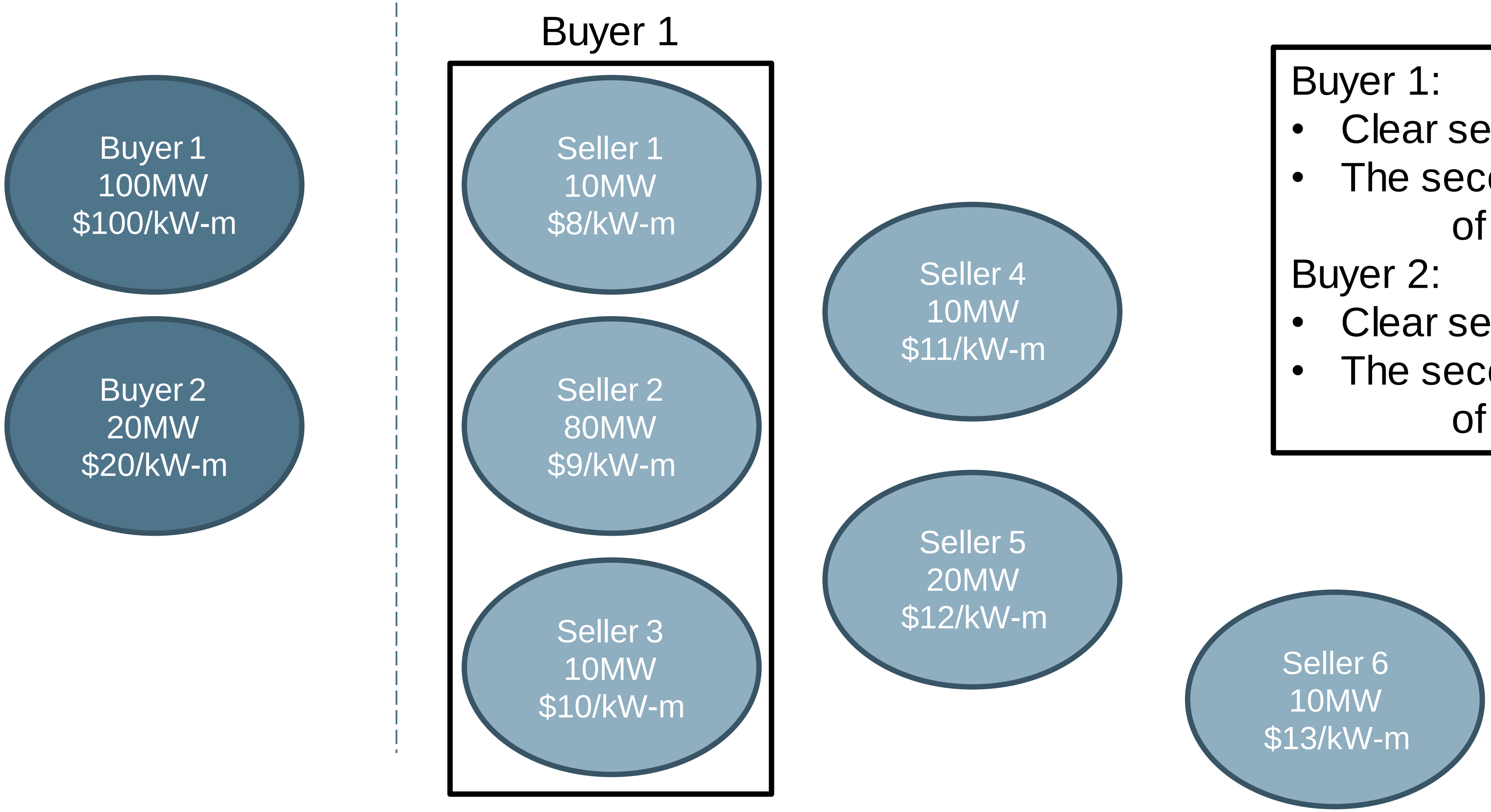


To meet the needs of buyer 1:

- Clear sellers 1-3
- The second price of $11/kW-month

Reverse second price auction example

A toy example for the outage substitution pool



Buyer 1:

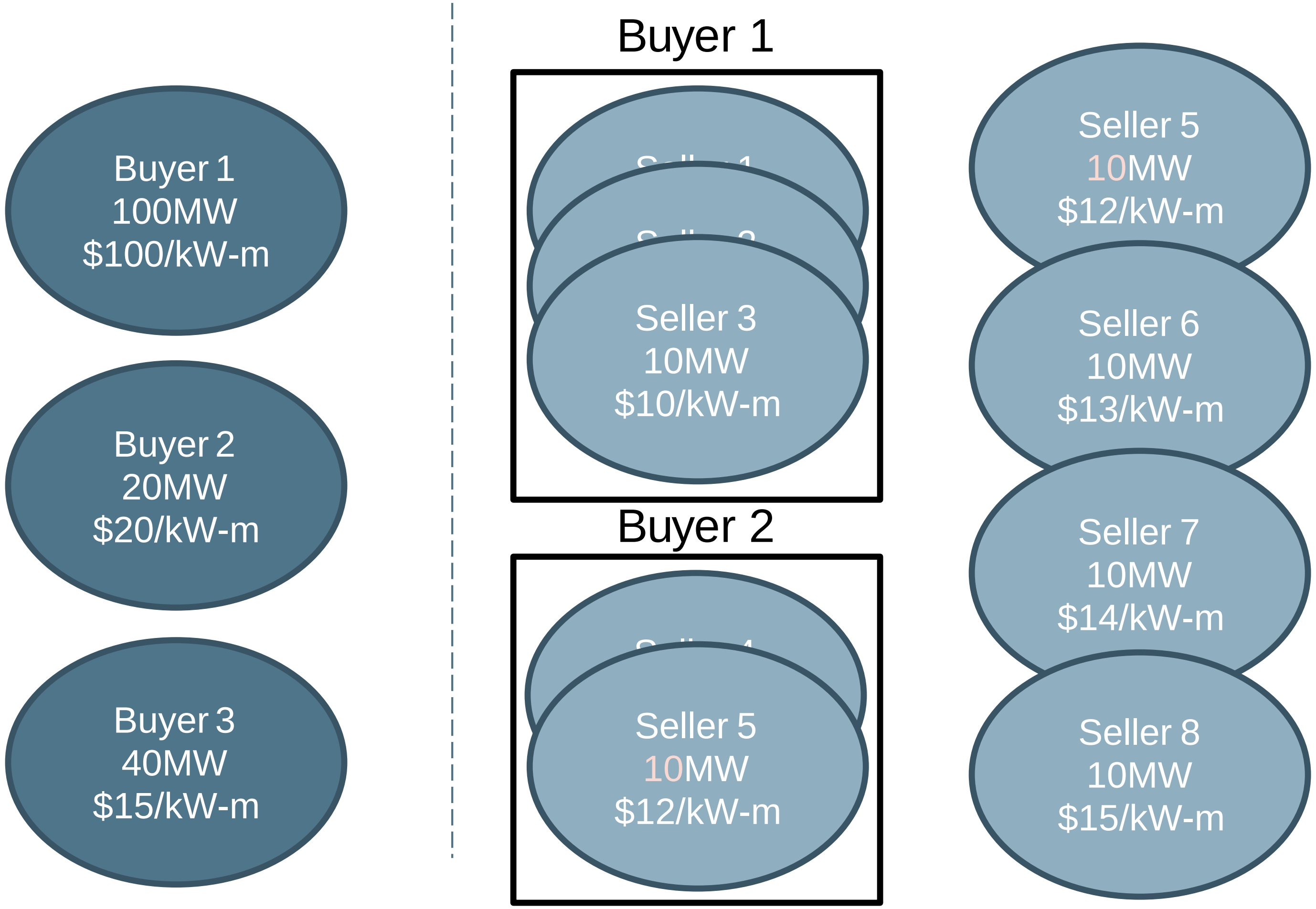
- Clear sellers 1-3
- The second price of $11/kW-month

Buyer 2:

- Clear sellers 4-5
- The second price of $13/kW-month

Reverse second price auction example

A toy example for the outage substitution pool



Buyer 1:
- Clear sellers 1-3
- The second price of $11/kW-month

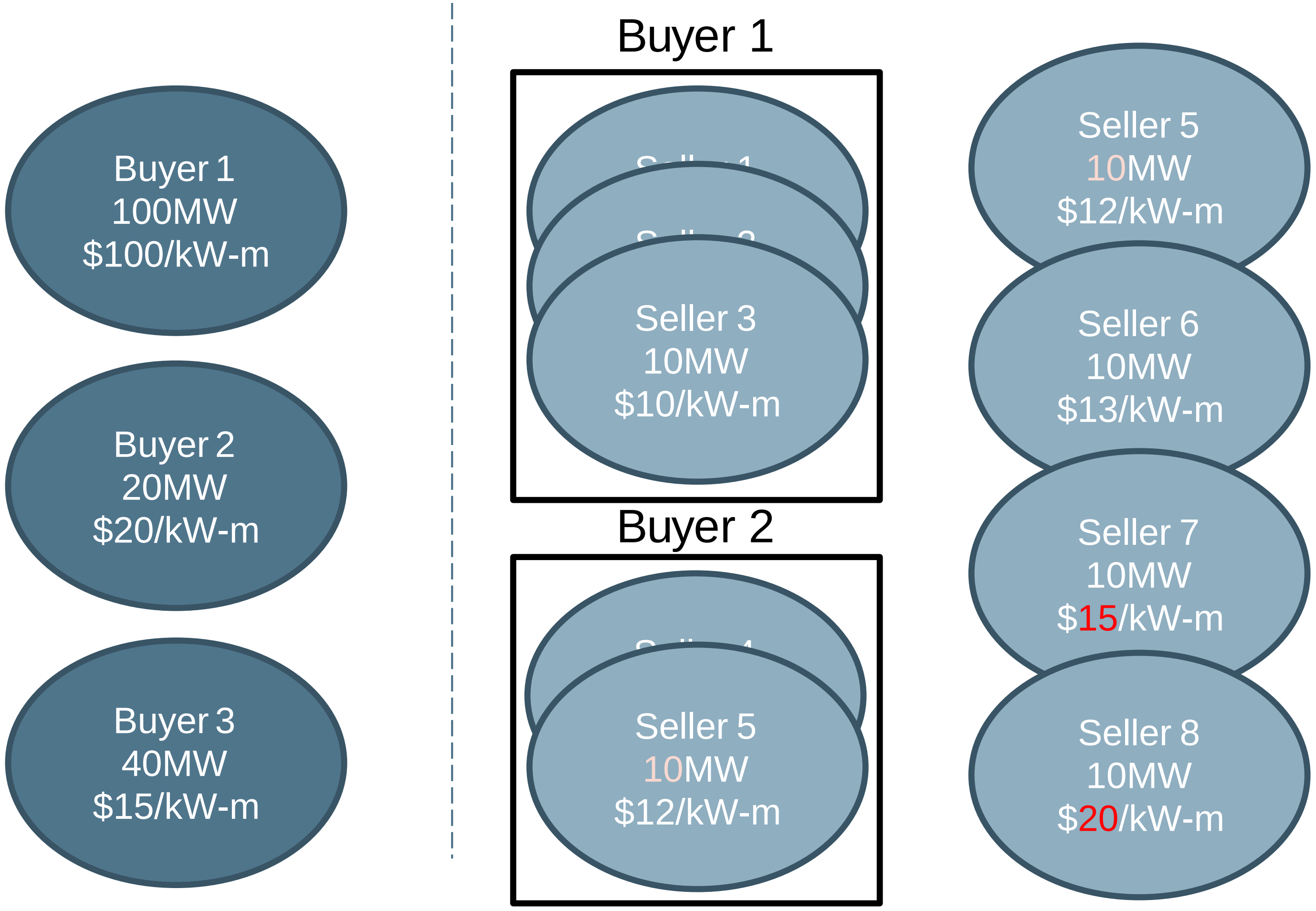
Buyer 2:
- Clear sellers 4-5
- The second price of $13/kW-month

Buyer 3:
- Clears sellers 5-8
- The second price of $15/kW-month

Market clearing:
- Price $15/kW-month

Reverse second price auction example – alternate

A toy example for the outage substitution pool



Buyer 1:
- Clear sellers 1-3
- The second price of $11/kW-month

Buyer 2:
- Clear sellers 4-5
- The second price of $13/kW-month

Buyer 3:
- Cannot clear the market due to prices

Market clearing:
- Price $13/kW-month

Reverse second price auction benefits

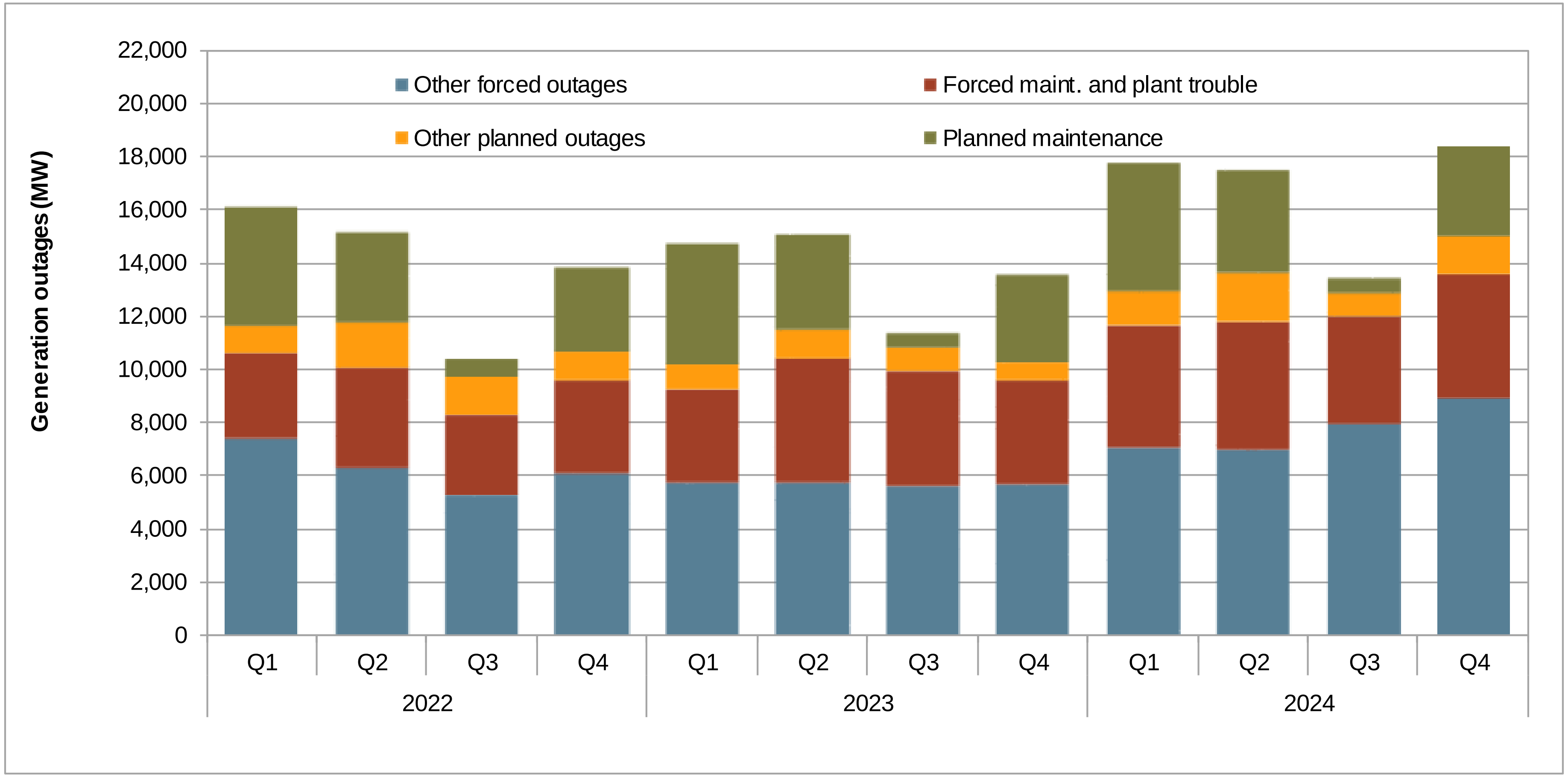
- **Cost Savings**: By encouraging suppliers to bid their true lowest price, buyers can achieve significant cost reductions.
- **Increased Competition**: This auction format fosters a competitive environment among suppliers. Knowing that suppliers need to offer their best price to win, they are motivated to reduce their bids to their reservation price, leading to competitive offers for the buyer.
- **Transparency**: The process is transparent, as all suppliers are aware of the bidding rules and the fact that the lowest bid wins but is paid the second-next price. This transparency can build trust and encourage more suppliers to participate.
- **Efficiency**: Auctions streamline the procurement process by reducing the time and effort needed for negotiations in bilateral markets. The auction format allows for quick decision-making and contract awards.
- **Encourages True-value Bidding**: Suppliers are incentivized to bid their true lowest price since they know they will receive the second-lowest bid amount if they win. This reduces the risk of inflated bids and ensures fair pricing.
- **Access to a Broader Supplier Base**: By using an auction platform, buyers can reach a larger pool of suppliers, including small and medium-sized enterprises that might not have been considered or found in traditional bilateral procurement processes.

Reverse second price auction concerns
General concerns from the literature

- **Bidder Strategy Complexity**: Bidders may find it challenging to determine the optimal bid, as they need to consider not only their costs but also predict the second-lowest bid.
  - Thick markets further incent participants to bid their true reservation price.
- **Risk of Collusion**: There is a potential for sellers to collude, agreeing to submit higher bids to ensure a higher second-lowest bid, which can undermine the auction's competitiveness.
  - Buyer reservation prices create a bid cap.
- **Quality Concerns**: Focusing solely on price can lead to lower quality goods or services.
  - Quality concerns are being taken up in other aspects of the RAMPD initiative.
- **Limited Participation**: Some suppliers may avoid participating due to the perceived complexity or potential for lower profit margins.
  - See next slide for the quantity of substitution capacity needed.
- **Bidder's Dilemma**: Bidders might hesitate to bid too low, fearing they might win at a price that barely covers their costs, leading to conservative bidding and less aggressive price reductions.

Appropriate market design can alleviate and/or mitigate these concerns

Quantity needs



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Design considerations

- The auction requires appropriate availability or performance incentives (and/or UCAP) to incent resources to use planned outages, instead of forced outages.
- Reservation prices on the supply and demand side will mitigate market power, however a discussion of market power in the auction would be in order.

Design considerations

- Allow for bilateral RA substitution contracting?
  - This may include the self-provision of outage substitution capacity
- Run this on a daily basis?
  - How to account for multiple day needs?
- Procurement at the SC-level?
- Voluntary offerings into the auction? (Similar to the CPM)
- Timing aligned with monthly RA showings and curings?
- Will this apply for generic and flex RA? (Re: RAAIM)

- Assumes NQC values can be treated 'like-for-like'.
  - This concern ought to be addressed elsewhere in the RAMPD initiative.

Summary

- An auction for the outage substitution pool creates efficiencies overcoming search and coordination frictions for substitution capacity.
- The *reverse* and *second price* aspects of the auction provide sound principles to ensure efficiencies, simplicities, and clear price formation by incentivizing buyers and sellers to bid their true value.
- Bidding in a second price auction is straightforward for buyers and sellers.
- The design incents price offers that are aligned with the true value of the capacity, creating cost savings, transparency, and a broad supply base.

References

- Wikipedia and LLMs (e.g. ChatGPT)
  - Great introductions to the topics
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