London Economics International LLC

Chapter 3 Preliminary Proposal Forward Stored Energy Reserve

Second presentation

NEPOOL MC meeting – June 11, 2019

Prepared on behalf of MA AGO

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Agenda

1	**Introduction and key takeaways**
2	FSER product definition and forward period
3	FSER auction format
4	FSER American call option, auction example

Overview: Forward stored energy reserve ("FSER") provides a fixed amount of insurance, for emergencies

Topics to be covered

- FSER product definition and forward period
- Auction format
- Auction for options, example

Topics for a future date

- FSER procurement size
- FSER settlement, including delivery of product
- Impact of settlement on LMPs

Key features

- FSER product definition and forward period can be designed to keep competition high and costs low, while providing a predictable investment signal
- Size of procurement established ahead of time
- Options are a low-cost way to buy insurance
- Auction format can be simple
- Other AS markets can stay as-is

FSER is a simpler alternative to ISO-NE's ESI proposal

- **ISO-NE's Chapter 3 design proposes the most substantial changes to the E&AS markets since inception. It is too soon to say whether ISO-NE's proposal will be effective from a reliability or cost perspective**
- **FSER is a simple and smaller-scale alternative to ISO-NE's complex scheme**
- **The FSER proposal:**

- **Does not require deep changes** to existing markets
- **Low(er) cost:** can be designed to be a small procurement; target could be based on probabilistic outcomes or scenario-based
- **Time-limited:** winter only, rather than year-round
- **Penalties for non-performance:** ensures that back-up energy supplies are maintained
- **Procured forward:** allows for LNG / oil procurement timeframes

Forward stored energy reserve (FSER) purpose and concept (review from March presentation)

- **Purpose: Create an energy reserve product which will provide inventory available to be called automatically when system conditions are very tight**
  - Enhances operator visibility, reduces posturing, may help prevent inefficient retirement
- **Concept: FSER serves as a call option for ISO-NE to exercise**
  - Forward time frame allows time for resources to arrange fuel supplies
  - ISO-NE decides the quantity of FSER to have on hand, then holds an auction ahead of the delivery period
  - FSER resources are paid an option price for stored energy
  - If the resource is called either in the DA or RAA process, the stored energy will earn a strike price
- **FSER is an ancillary service which would be integrated into the DA market**
  - ISO-NE would use the strike price to know when and how much FSER to call DA
  - The DA energy market will clear at the strike price offered by the most expensive FSER resource needed, or the offer of the most expensive energy resource needed
  - This helps preserve the market signal when supplies are tight

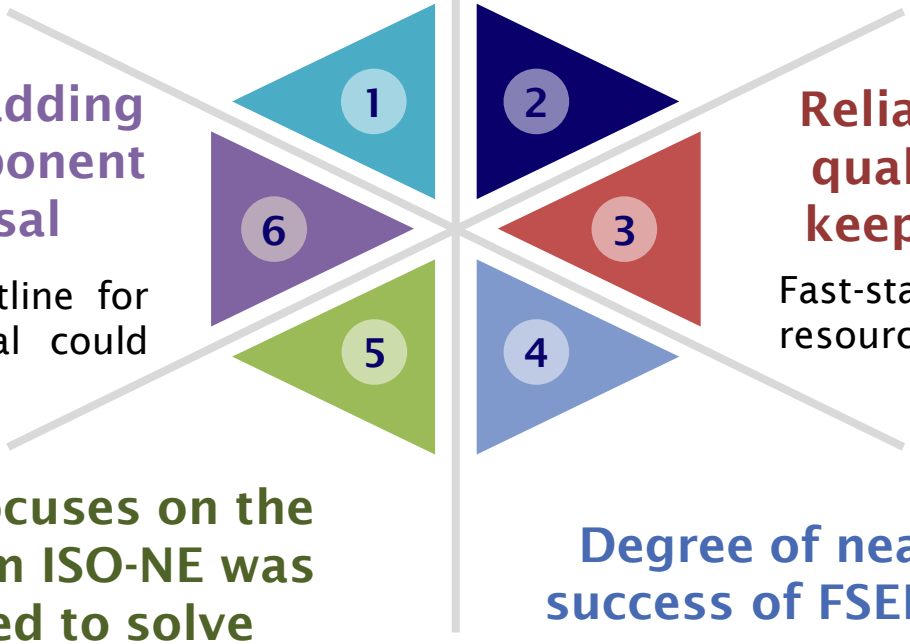
FSER is worth pursuing because it addresses key concerns around energy security

Forward period helps keep costs down

Seasonal or monthly procurement (as opposed to day-ahead) allows time to acquire lower-cost stored energy

FSER is designed to a specific procurement target which will help keep costs down

ISO-NE establishes quantity of FSER needed, ahead of time



ISO-NE will be adding a forward component to its proposal

FSER provides the outline for what such a proposal could look like

Reliance on lower-quality resources keeps costs down

Fast-start and/or fast-ramp resources are not needed

FSER focuses on the problem ISO-NE was tasked to solve

FERC Order is focused on winter energy security

Degree of near-term success of FSER can be measured

E.g., by number of OP-4 events

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FSER is a homogenous good, measured in MWh

- Ancillary service
- Reservoir of stored energy
- Procured in advance

One FSER unit = 1 MWh that can be called DA by ISO-NE over the term for which it is offered

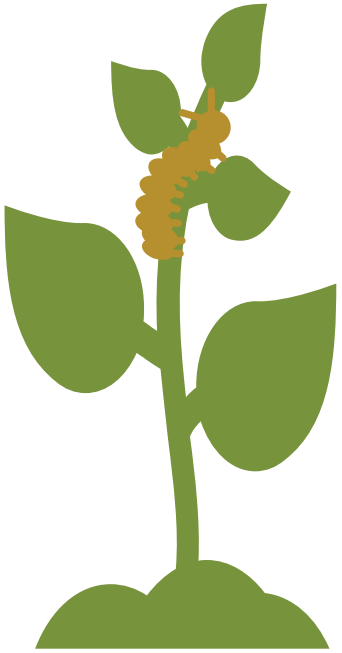
- Provider can offer multiple units (multiple MWh)
- Provider tells ISO how many units can be called in a given hour

ISO-NE determines the total quantity it needs for the winter period (e.g., December-March) or month

Speed of responsiveness (fast-start, etc.) is not important, because FSER would be committed in the day ahead market, not in real-time*

*FSER is not intended to replace TMNSR or TMOR, nor to provide spinning reserves. Therefore, the FSER product definition will not make distinction for start or ramp times, so no value will be attributed to faster start times.

FSER forward auction timeframe must balance need for lead time to procure energy cost-effectively, and need for information about the amount of such energy which is likely to be called



- Water-born LNG contracting (including for LNG supplies into Canaport) ideally begins in April for following winter
- This implies forward period of 6 months; but that is long in advance of when ISO-NE's winter needs start to crystalize—shorter forward period could work for spot LNG cargos and other sources of stored energy
- Forward time frame is not intended to favor LNG, but to include it in order to expand the set of resources which can bid, which will increase competition and in that way lower costs
- No need to build new infrastructure, only to incentivize using what is already in place in New England, so the forward period does not have to be years ahead

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LEI/AGO recommends simple auction format: Sealed bid, with uniform clearing price

LEI/AGO prefers uniform clearing price, but other formats are possible

Uniform clearing price: Each bidder which clears the auction is paid the same price as the highest-cost bid which clears

PROS

Only one bidder will suffer from winner's curse;
Bidders can submit low bids (at short-run marginal cost ("SRMC") for low-cost (infra-marginal) plants, ensuring they will be chosen

CONS

Bidder might have unilateral incentive to raise bid price over SRMC for plants it expects to be marginal

Bidder could engage in portfolio bidding

Pay-as-Bid: Each bidder which clears the auction is paid its own bid

PROS

Could, in theory, result in lower-cost of procurement than uniform clearing price (if all bidders bid SRMC– that could be a big "if")

CONS

All bidders incentivized to bid higher than SRMC, because if they do not, they have no chance of profit (fall prey to winner's curse); Bidders may try to bid the cost of the next-highest bidder, or guess at the market-clearing price and bid that amount

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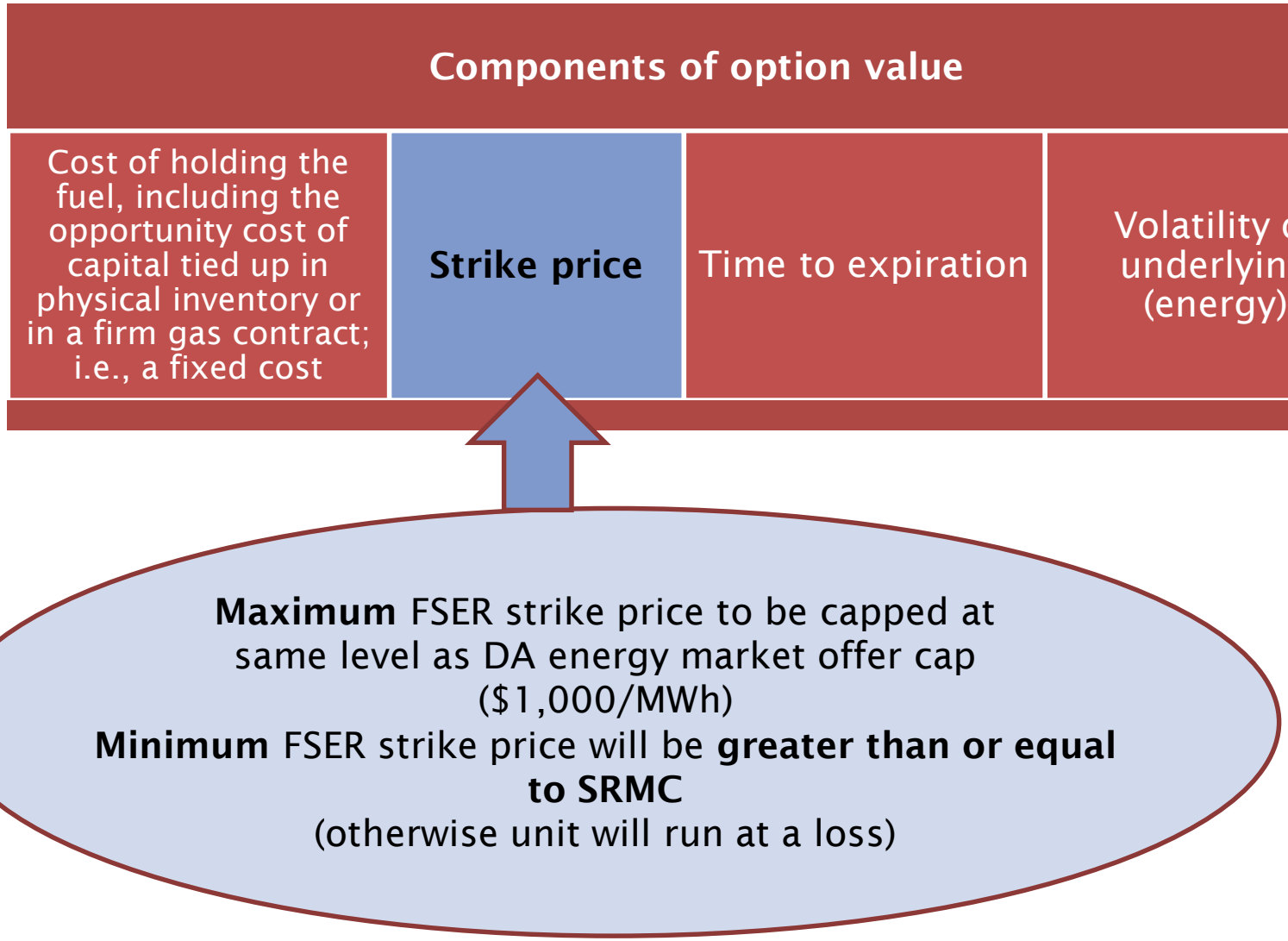
Bidder specifies option premium as well as strike price

- Each bidder asked to bid (offer an option premium and associated strike price) for its MWh and how many units can be used simultaneously
- **It is up to the bidder determine what its option premium and strike price should be**
  - Algorithms are available which allow bidders to evaluate many combinations, and for auctioneers to calculate optimal bid combinations (see simplified example in next section)

Costs included in option value	Costs included in strike price
· Strike price · Fixed cost of securing fuel or energy, including opportunity cost of capital tied up in inventory · Convenience yield (the implied return) from holding fuel inventories · Potential lost opportunity cost/foregone energy revenue	· Variable cost of fuel · Other variable operating costs · Start-up costs & ramping costs

How the value of the option is determined



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Auction example: Three steps

Step 1

- Example of how one bidder might determine its bid for an American call option
- Bid depends on strike price offered, costs and other factors, illustrated by Black-Scholes model for simplicity

Step 2

- ISO-NE determines it needs 30,000 MWh for a given month
- ISO-NE also determines MWh needed in any given hour, e.g., 1,500 MW
- Sealed-bid auction with uniform clearing price
- Auction attracts 14 bids

Step 3

- Auction mechanics, with example of a simple scoring rule to determine auction winners
- The scoring rule is not the only option for clearing the auction - it is just an example for presentation purposes
- Bidders should be told the scoring rule ahead of the auction

Step 1: A bidder's determination of option value depends on the strike price it offers, expected costs, and other factors

	Black Scholes* assumptions and calculations	ISO-NE FSER energy option	
Assumptions	On-peak January 2020 forward price, in $/MWh (S)	$	79.00
	Strike price, aka Exercise Price, in $/MWh (K)	$	140.00
	r + q (risk free rate + fixed cost as % of energy price)		0.456
	Time to maturity as % of year (T)		0.74
	Volatility (Std Dev) (daily average January volatility)		0.70
Components of Black-Scholes calculations	Variance		0.49
	ln(S/K)		-0.57
	[r+0.5(variance)]*T		0.52
	std dev * sqrt (T)		0.60
	d1		-0.09
	N(d1)		0.46
	d2		-0.69
	N(d2)		0.24
	K/e^rT		99.90
	Option value (price) in $/MWh	**$**	**12.25**

Bidder specifies option price per MWh, and strike price per MWh

This is a hypothetical example

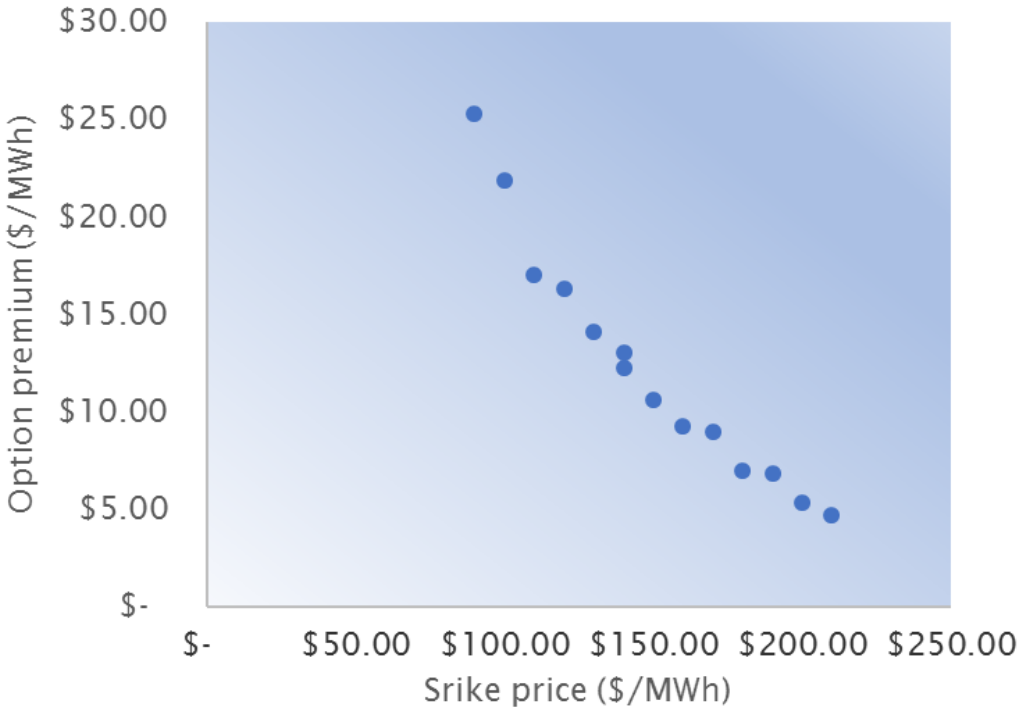
*Black-Scholes is used in this example for simplicity, though, for American call options a more complex formula such as the Barone-Adesi & Whaley approximation model would be used.

Step 2: Different bidders arrive at different combinations of strike prices and option premia

Bidders provide **sealed bids** with **option premium and strike price for MWh**

The bids vary depending on bidders' independent evaluations of costs and other factors, as well as the strike price the bidder wants to offer

14 bids with a variety of strike price versus option premium



Step 3: Bid evaluation (scoring) is based on option premium and strike price

Hypothetical scoring rule: Accept the bids in order of lowest total expected cost per MWh to highest until reaching 30,000 MWh; i.e., evaluate:
(Option price) + (Strike price * probability), subject to Min MW in an hour = 1,500

Bid number	Option premium ($/MWh)	Maximum MW in an hour	MWh	Strike price offered ($/MWh)	Probability	Probability-weighted strike price	Total expected cost per MWh
14	$ 4.69	50	600	$ 210.00	5%	$ 10.50	$ 15.19
13	$ 5.35	100	1,200	$ 200.00	5%	$ 10.00	$ 15.35
11	$ 7.01	10	120	$ 180.00	5%	$ 9.00	$ 16.01
12	$ 6.80	10	120	$ 190.00	5%	$ 9.50	$ 16.30
9	$ 9.23	50	600	$ 160.00	5%	$ 8.00	$ 17.23
10	$ 9.00	500	2,400	$ 170.00	5%	$ 8.50	$ 17.50
8	$ 10.63	100	1,200	$ 150.00	5%	$ 7.50	$ 18.13
1	$ 12.25	500	18,000	$ 140.00	5%	$ 7.00	$ 19.25
7	$ 13.00	10	1,200	$ 140.00	5%	$ 7.00	$ 20.00
6	$ 14.13	100	1,200	$ 130.00	5%	$ 6.50	$ 20.63
5	$ 16.33	50	600	$ 120.00	5%	$ 6.00	$ 22.33
4	$ 17.00	200	4,800	$ 110.00	5%	$ 5.50	$ 22.50
3	$ 21.86	100	1,800	$ 100.00	5%	$ 5.00	$ 26.86
2	$ 25.29	50	1,200	$ 90.00	5%	$ 4.50	$ 29.79

The total MWh bid was 35,040 MWh; bid numbers in grey did not clear
All cleared resources receive uniform clearing price of $17/MWh

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Eligibility rules, pre-determined quantity, maximum and minimum strike price rules, and auction format together prevent gaming

If gaming is defined as bidding a low option premium and a low strike price so as to be sure to win auction and be sure to be called in DA

- **Eligibility rules** requires resources which (a) can set aside energy in storage and (b) have an opportunity cost for putting energy into storage. These eligibility requirements prevent units from bidding a low strike price and low option premium, therefore earning the option premium in addition to energy revenues for energy which they would have bid into the DA regardless of FSER
- The **pre-determined need** is small relative to the total size of the energy market
- The lowest strike price which is likely to be offered is the SRMC of a unit; if a unit's strike price is lower than that, it will lose money if called

If gaming is defined as bidding a low option premium to win in the auction, but high strike price so as never to be called

- The **maximum strike price** which can be offered is capped consistent with energy market offer caps
- The higher the strike price, the less likely a bid will be to win the auction, even if the option premium is low, because the **expected value of the strike price is a component of the bid evaluation, as demonstrated previously**

Conclusions

Key takeaways

- FSER product definition and forward period can be designed to keep competition high and costs low
- Provides a predictable investment and fuel procurement signal
- Options are a low-cost way to buy insurance, e.g., stored energy
- Auction format can be simple
- Designed to be used less frequently than the ESI, so likely to have less impact on energy revenues and cost to customers

Topics for a future date

- FSER procurement size
- Impact of settlement on LMPs
- Example of calling and commitment


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