

Southeast Energy Exchange Market (SEEM)

Market Principles

Network Model, Market Engine, & Match Examples

May 2022



Overview

- Traditional Hourly Bilateral Trading vs SEEM
- SEEM Data Flow Concepts, Inputs and Processes
 - Network Model
 - NFEETS
 - Financial Loss Factors
 - Financial Loss Rates
 - Market Participant Information (bids\offer)
- Market Engine
 - Constraints
 - Calculations
 - Examples



Traditional Hourly Bilateral Market vs SEEM

Traditional Hourly Bilateral Market

- Traders must understand their cost, current market, and transmission constraints.
- Every hour traders must individually call or IM counterparties to negotiate transactions. During negotiations traders talk through MWs, delivery point, transmission availability, and price which includes any transmission costs that must be factored into the final price.
- Once a transaction is agreed upon each trader must reserve any needed transmission (from one-to-many TSPs).
- Once all transmission is reserved, one of the traders will enter an eTag which will turn into a schedule in each of the impacted EMS systems.
- Each trader will manually then enter the transaction into their ETRM system to feed other systems including settlement.

SEEM

- Traders must understand their cost, and the current market (not as much focus on transmission).
- Every 15 minutes traders enter bids and offers into the SEEM Platform either manually or via APIs. Bids and offers include source, sink, MWs, price, and other optional parameters. The SEEM Platform Market Engine uses bid\offer data, transmission constraints (zero cost!), the network model, user defined constraints, and the market rules to match buyers and sellers together with split the savings pricing.
- The SEEM Platform automatically reserves all needed transmission.
- The SEEM Platform automatically enters an eTag which will turn into a schedule in each of the impacted EMS systems.
- The SEEM Platform will produce data that can be used to enter transactions (manually or via API) to each trader's ETRM system to feed other systems including settlement.

SEEM Data Flow

Inputs

Network Model – Source/Sink
POR/POD,
SEEM Segment, SEEM Path

Available NFEETS (MWs)

Financial Loss Rates (\$/MWh)
Loss Factors (%)

Bid Price, Volume, Sink,
Offer Price, Volume, Source,
Counterparty Constraints,
Delivery Location Constraints

SEEM Platform (Hartigen)

User Interface/API:

- Enter/Modify input data
- View results/run reports

Market Engine

- Runs every 15 minutes
- Matches buyers/sellers
- Reserves transmission
- Creates e-Tags
- Produces data used for settlement

Outputs

TSR

e-Tag

15-Min Transaction Record
Counterparty, Volume/Price,
Buy/Sell Location, Start/Stop
Time, Path, Aref, Tag Code

Network Model Concepts

BA

Source

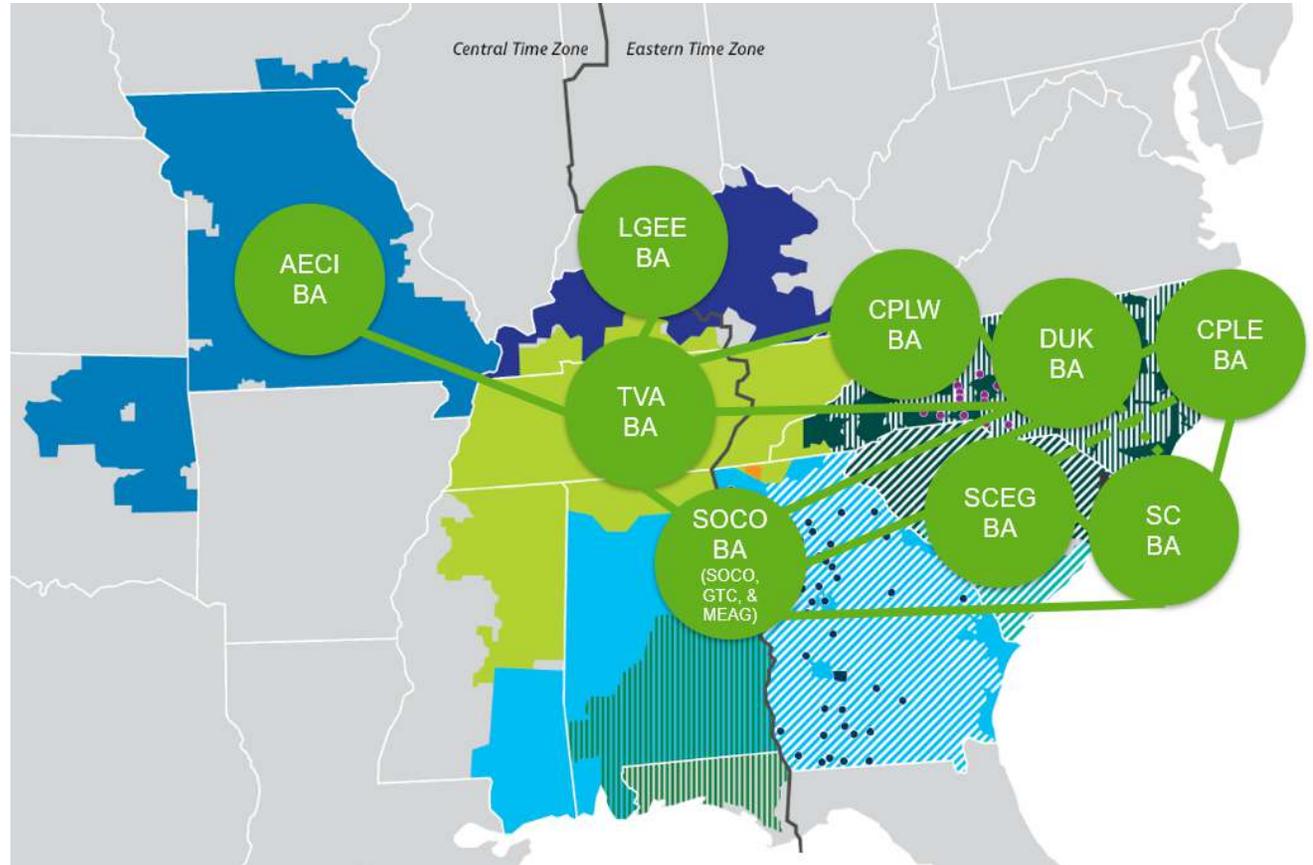
Sink

POR

POD

SEEM Segment

SEEM Path



Network Model Concepts

Balancing Area – Collection of generation, loads, and transmission within a metered area.

Generation - Source

Load – Sink

Transmission

- Right to use transmission lines
- Authorized by TSPs (Transmission Service Providers)
- Granted through TSRs (Transmission Service Requests) which are entered into OASIS (Open Access Same Time Information System)

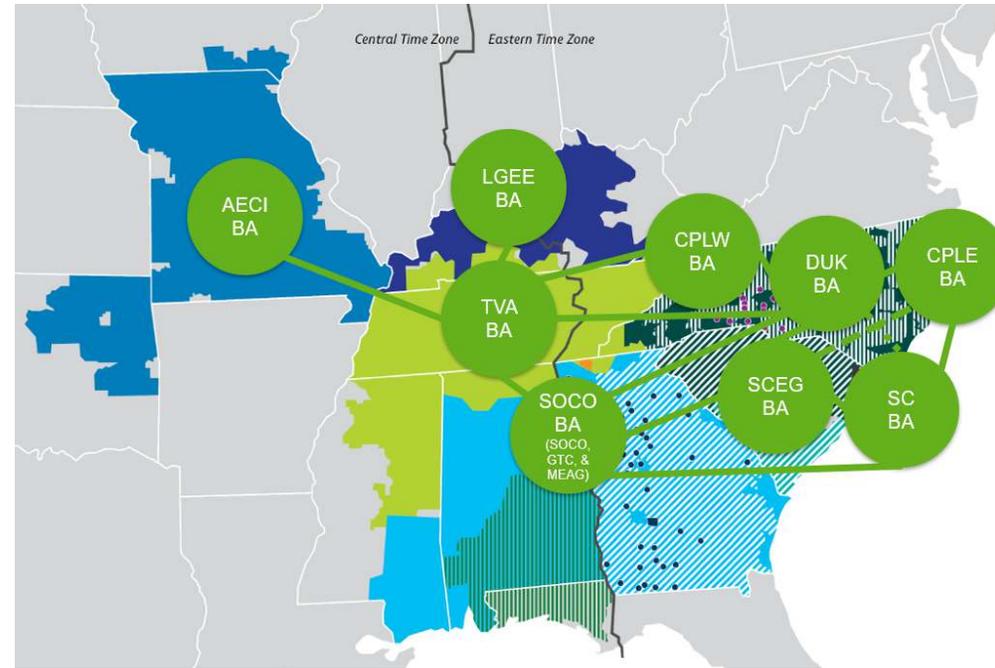
Balancing Areas are connected by transmission lines at specific points referred to as PORs (Points of Receipt) and PODs (Points of Delivery)

- PORs and PODs are typically also BA names, but not always
- BAs are connected to one-to-many other BAs

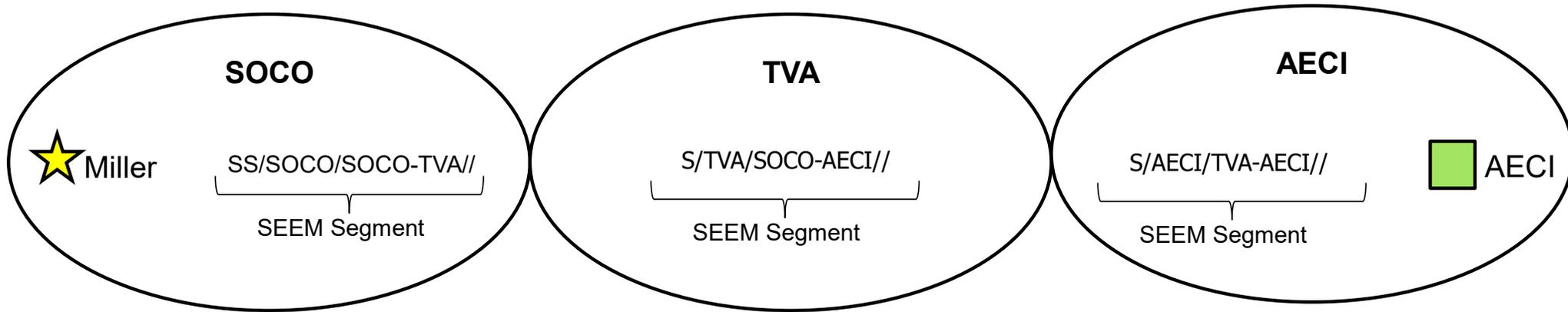
SEEM Segment (aka Transmission Leg) – Formatted combination of a TSP, POR, and POD

- Example - SS/SOCO/SOCO-TVA
 - Flowing power on SOCO transmission from a SOCO source to the TVA border
 - SS – Prefix in OASIS that has limited relevance
 - SOCO (first one) – The TSP who owns the transmission lines
 - SOCO-TVA = POR and POD

SEEM Path (aka Transmission Path) – The concatenation of multiple SEEM Segments.



SOCO to AECI Network Model Example



SEEM Path = SOCO-TVA-AECI

Other Potential Paths

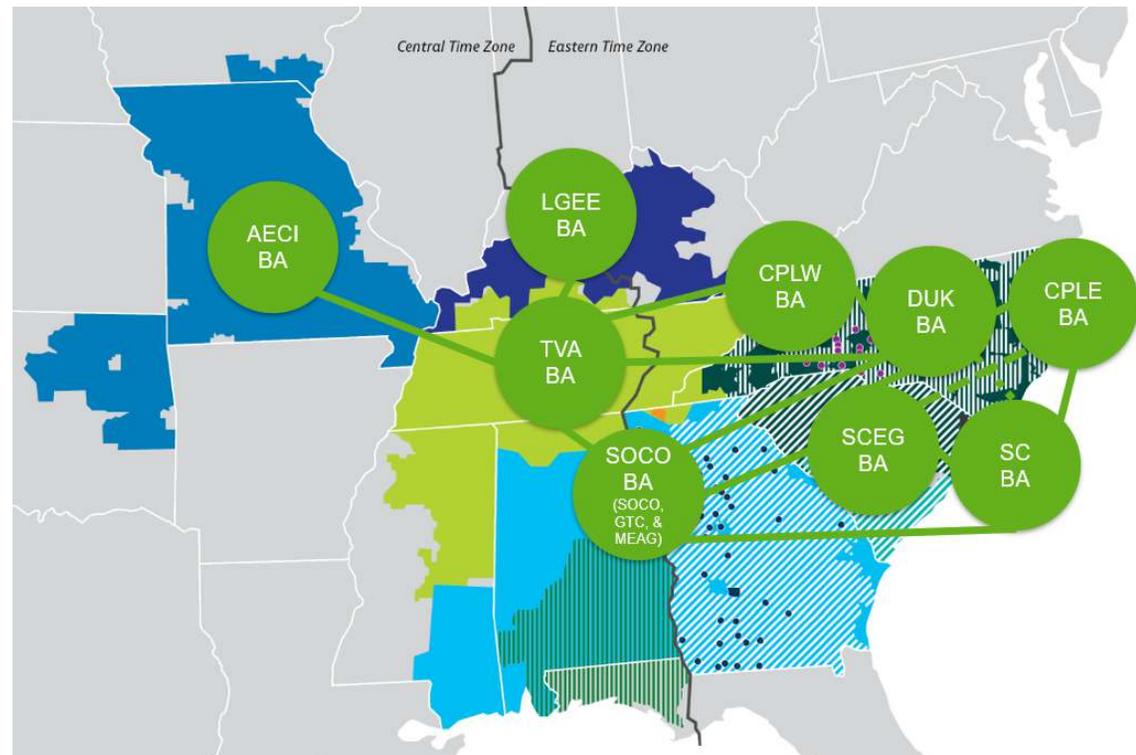
- SOCO-GTC-TVA-AECI
- SOCO-DUK-TVA-AECI
- SOCO-SC-DUK-TVA-AECI
- SOCO-GTC-DUK-TVA-AECI
- SOCO-SCEG-SC-DUK-TVA-AECI
- SOCO-MEAG-GTC-SCEG-SC-CPL (CPLW)-TVA-AECI

SOCO-DUK-CPL (CPLW)-TVA-AECI	SOCO-GTC-SC-DUK-TVA-AECI	SOCO-MEAG-SCEG-SC-CPL (CPLW)-DUK-CPL (CPLW)-TVA-AECI
SOCO-SC-CPL (CPLW)-DUK-CPL (CPLW)-TVA-AECI	SOCO-GTC-SC-SCEG-CPL (CPLW)-DUK-CPL (CPLW)-TVA-AECI	SOCO-MEAG-SCEG-SC-CPL (CPLW)-DUK-TVA-AECI
SOCO-SC-CPL (CPLW)-DUK-TVA-AECI	SOCO-GTC-SC-SCEG-CPL (CPLW)-TVA-AECI	SOCO-MEAG-SCEG-SC-DUK-CPL (CPLW)-TVA-AECI
SOCO-SC-CPL (CPLW)-SCEG-DUK-TVA-AECI	SOCO-GTC-SC-SCEG-DUK-TVA-AECI	SOCO-MEAG-SCEG-SC-DUK-TVA-AECI
SOCO-SCEG-CPL (CPLW)-DUK-TVA-AECI	SOCO-MEAG-SC-SCEG-CPL (CPLW)-DUK-TVA-AECI	SOCO-MEAG-GTC-DUK-TVA-AECI
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SOCO-MEAG-SC-DUK-TVA-AECI	SOCO-GTC-SCEG-SC-CPL (CPLW)-TVA-AECI	
SOCO-GTC-SC-DUK-CPL (CPLW)-TVA-AECI	SOCO-GTC-SCEG-SC-DUK-TVA-AECI	

SOCO to AECI SEEM Paths = 92

Network Model Stats

- 9 BAs
- 11 TSPs
- Over 240 unique SEEM Segments
- Over 16,000 unique SEEM Paths
- Shortest Path – 1 SEEM Segment (intra BA)
- Longest Path – 10 SEEM Segments



SEEM Data Flow

Inputs

Network Model – Source/Sink
POR/POD,
SEEM Segment, SEEM Path

Available NFEETS (MWs)

Financial Loss Rates (\$/MWh)
Loss Factors (%)

Bid Price, Volume, Sink,
Offer Price, Volume, Source,
Counterparty Constraints,
Delivery Location Constraints

SEEM Platform (Hartigen)

User Interface/API:

- Enter/Modify input data
- View results/run reports

Market Engine

- Runs every 15 minutes
- Matches buyers/sellers
- Reserves transmission
- Creates e-Tags
- Produces data used for settlement

Outputs

TSR

e-Tag

15-Min Transaction Record
Counterparty, Volume/Price,
Buy/Sell Location, Start/Stop
Time, Path, Aref, Tag Code

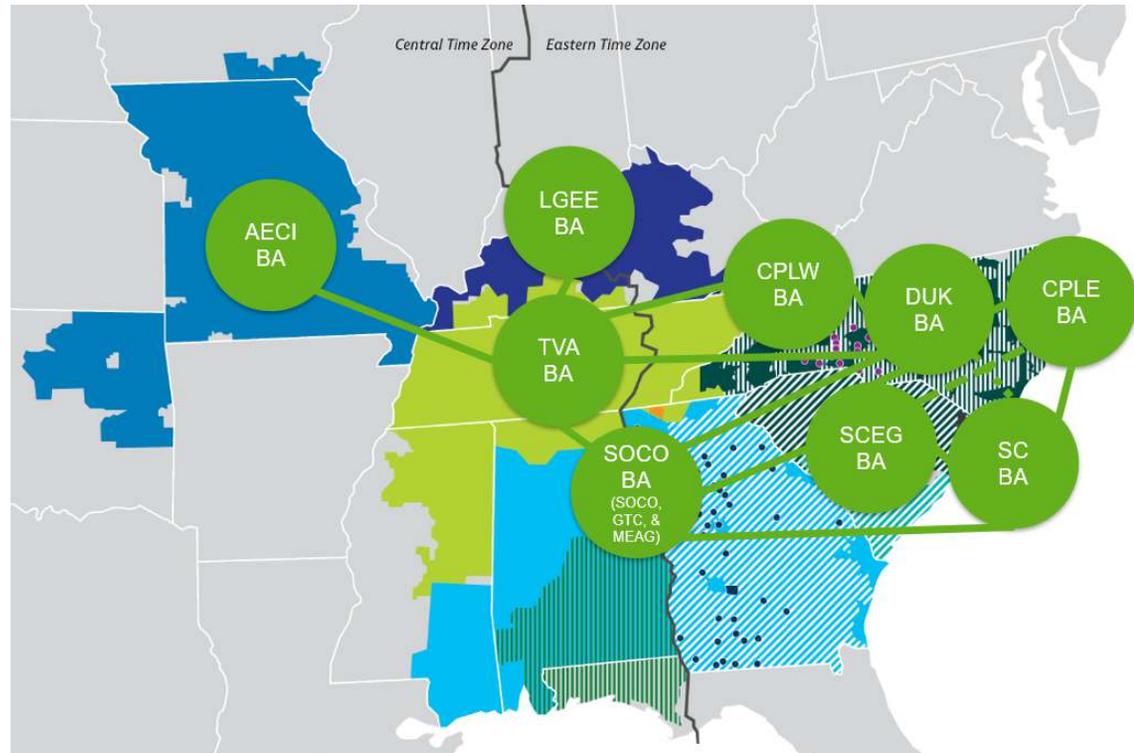
Non-Firm Energy Exchange Transmission Service (NFEETS)

- Provided under each Participating Transmission Provider's Open Access Transmission Tariff ("OATT")
- Lowest priority, non-firm service
- \$0/MWh transmission service rate and Schedule 1 and 2 ancillary services
- Each SEEM Segment will have a NFEETS ATC value
- Only available for SEEM transactions (cannot be used for anything else)
- All SEEM related transmission is NFEETS
 - No PTP Transmission
 - No Network Transmission



NFEETS Constraints

- The SEEM Platform will pull the NFEETS ATC value for each SEEM Segment from OASIS.
- Netting of scheduled flows will not be allowed (i.e., as far as the engine is concerned, SOCO to TVA is a separate value; TVA to SOCO is a separate value.)
- No Looped Transactions
 - Each transaction can only flow across a TSP one time.



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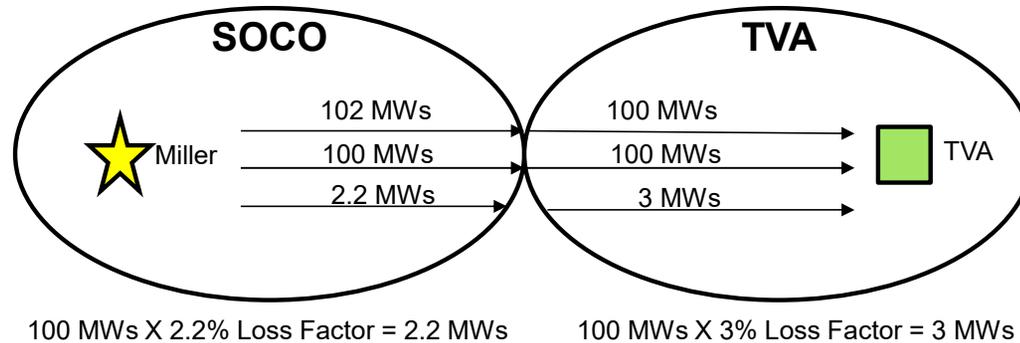
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e-Tag

15-Min Transaction Record
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Buy/Sell Location, Start/Stop
Time, Path, Aref, Tag Code

Losses



- Losses account for the lost power as energy flows across transmission lines.
- Physical Losses – Not used for SEEM
 - Accounted for on eTags
 - Usually calculated as a % but must be converted to a whole number for tagging purposes. Each TSP can handle the fractional MWs differently which can make calculating physical losses complicated.
- Financial Losses – Used for all SEEM transactions
 - Not accounted for on eTags
 - TSPs provide a Loss Factor (%) and Loss Rate (\$/MWh) to the SEEM Platform and are not trued up after the fact.
 - Loss Factors are fairly static (may be updated annually, bi-annually, etc. per TSP's tariff)
 - Loss Rates will change more frequently but it is up to each individual TSP. Loss Rates are used to recover the cost of generation dispatching up to cover any line losses so it will typically be tied to system cost in some way but that is up to each TSP.
 - All SEEM Segments in a SEEM Path will have Financial Losses. Even the sinks segments which typically do not incur any losses today.

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e-Tag

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Time, Path, Aref, Tag Code

SEEM Buyer Info (Bidders)

- Entity Name
- Bid Volume (MW) and 'All or Nothing' selection
- Bid Price (\$/MWh) - Max price to buy
- Location (Sink)
- Interval (which 15-minute increment)

SEEM Seller Info (Offeror)

- Entity Name
- Offer Volume (MW) and 'All or Nothing' selection
- Offer Price (\$/MWh) - Minimum price to sell
- Location (Source)
- Interval (which 15-minute increment)

SEEM User Constraints

- Bids and offers must be in 4MW increments

- 'All or Nothing' selection
 - Yes:
 - Full volume must clear
 - Multiple transactions can be matched to meet the full volume requirement
 - No:
 - Partial volume may clear
 - No max volume
 - Multiple transactions can be matched at or below the partial volume requested

SEEM User Constraints cont'd

- All participation in SEEM is voluntary and Participants can enable/disable counterparties and trade locations
- Per FERC Filing: Participants shall not be required to provide a reason for any Participant-Specific Constraint. The reason for such constraints could be, but is not limited to, the following:
 - Lack of Enabling Agreement
 - Counterparty issues (e.g., credit)
 - Affiliate Restrictions
 - Geographic issues causing supply or deliver point restrictions and regulatory requirements

SEEM Data Flow

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15-Min Transaction Record
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Market Engine – Optimization Objective

- The Southeast EEM Algorithm will match Bids and Offers in Energy Exchanges (trades/transactions) to maximize the Southeast Energy Exchange Market total benefit for the applicable Delivery Interval while simultaneously honoring all the requirements and constraints identified in the Market Rules.
- The benefit associated with each Energy Exchange will be calculated by taking the difference between the Bid and Offer price multiplied by the MW amount of the non-firm energy, less the costs of transmission losses provided along the contract path.

SEEM General Market Constraints

- Total trade volume cannot exceed ATC per transmission path
- Buyer cannot buy volume greater than bid; seller cannot sell volume greater than offer
- Buyer cannot buy at a price greater than bid; seller cannot sell at a price lower than offer
- Total volume of trades will not exceed total volume of bids or offers
- Participant bids cannot be matched with own offer
- Sell and buy trades cannot be created between the same participants at the same location during the same interval
- Multiple trades and offers for varying source/sink locations may be submitted during the same interval

SEEM Trade Price Calculation

Trade Price (\$/MWh) =

$$(1/2)(\text{Seller's Offer Price} + \text{Buyer's Bid Price}) + \\ (1/2)(\text{Seller's Financial Loss Rate} - \text{Buyer's Financial Loss Rate})$$

Where (n is the number of paths):

$$\text{Seller's Financial Loss Rate (\$/MWh Rate)} = \\ (\text{TSP}_1 \text{ Loss Rate}) \times (\text{TSP}_1 \text{ Loss Factor}) + \\ \dots + \\ (\text{TSP}_{n-1} \text{ Loss Rate}) \times (\text{TSP}_{n-1} \text{ Loss Factor})$$

$$\text{Buyer's Financial Losses (\$/MWh Rate)} = \\ (\text{TSP}_{\text{Sink}} \text{ Loss Rate}) \times (\text{TSP}_{\text{Sink}} \text{ Loss Factor})$$

Note: Loss Rate is \$/MWh and Loss Factor is %

SEEM Bid/Offer Example #1

$$\begin{aligned} \text{Trade Price (\$/MWh)} = & \\ & (1/2)(\text{Seller's Offer Price} + \text{Buyer's Bid Price}) + \\ & (1/2)(\text{Seller's Financial Loss Rate} - \text{Buyer's Financial Loss Rate}) \end{aligned}$$

Financial Loss Rate

- TSP1 = \$24/MWh x 1.95% = \$0.468/MWh
- TSP2 = \$32/MWh x 2.00% = \$0.640/MWh

$$\begin{aligned} \text{Trade Price} = & (1/2) \times (20 + 30)(\$/\text{MWh}) + \\ & (1/2) \times (0.468 - 0.640) (\$/\text{MWh}) \\ = & \$24.914/\text{MWh} \end{aligned}$$

Entity 1 in BA1 – Seller
Offer Price - \$20/MWh
Offer Volume - 48 MW



Entity 2 in BA2 – Buyer
Bid Price - \$30/MWh
Bid Volume - 48 MW

SEEM Bid/Offer Example #1 cont'd

Trade Price = \$24.914/MWh

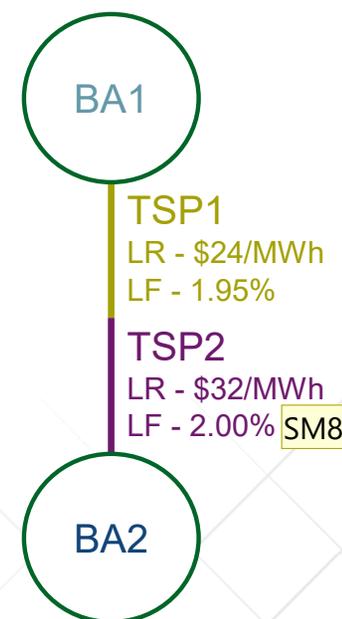
Settlement

- Buyer (Entity 2) owes Seller (Entity 1) for non-firm energy trade
 - $(\$24.914/\text{MWh}) \times (48 \text{ MW}) / 4 \text{ periods per hour} = \298.97
- Seller (Entity 1) owes TSP1 for financial losses
 - $(\$24/\text{MWh}) \times (1.95\%) \times (48 \text{ MW}) / 4 \text{ periods per hour} = \5.62
- Buyer (Entity 2) owes TSP2 for financial losses
 - $(\$32/\text{MWh}) \times (2.00\%) \times (48 \text{ MW}) / 4 \text{ periods per hour} = \7.68

Benefit

- Buyer: Avoided Cost – Trade Costs = $\$(30 \times 48 / 4) - \$298.97 - \$7.68$
 - \$53.35
- Seller: Deal Revenue – Cost to Serve Sale = $\$298.97 - \$(20 \times 48 / 4) - \$5.62$
 - \$53.35

Entity 1 in BA1 – Seller
Offer Price - \$20/MWh
Offer Volume - 48 MW



Entity 2 in BA2 – Buyer
Bid Price - \$30/MWh
Bid Volume - 48 MW

Slide 24

SM8 updated to 2% to match the math
Stickney, Michael, 5/11/2022

SEEM Bid/Offer Example #2

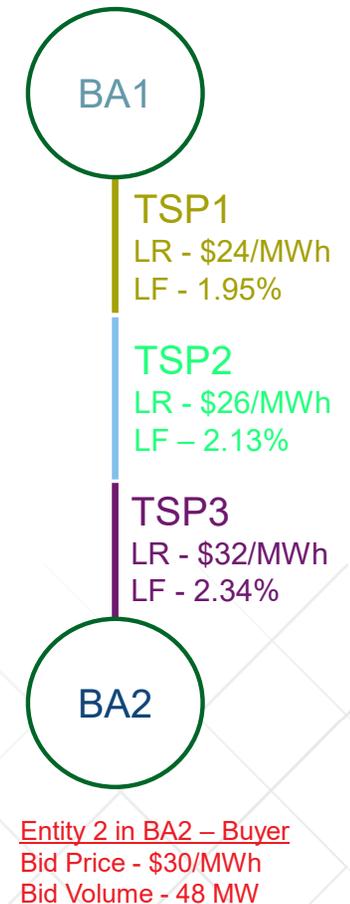
Entity 1 in BA1 – Seller
Offer Price - \$20/MWh
Offer Volume - 48 MW

Trade Price (\$/MWh) =
 $(1/2)(\text{Seller's Offer Price} + \text{Buyer's Bid Price}) +$
 $(1/2)(\text{Seller's Financial Loss Rate} - \text{Buyer's Financial Loss Rate})$

Financial Loss Rate

- TSP1 = \$24/MWh x 1.95% = \$0.468/MWh
- TSP2 = \$26/MWh x 2.13% = \$0.5538/MWh
- TSP3 = \$32/MWh x 2.34% = \$0.7488/MWh

Trade Price = $(1/2) \times (20 + 30) (\$/\text{MWh}) +$
 $(1/2) \times ((0.468 + 0.5538) - 0.7488) (\$/\text{MWh})$
= \$25.1365/MWh



SEEM Bid/Offer Example #2 cont'd

Entity 1 in BA1 – Seller
Offer Price - \$20/MWh
Offer Volume - 48 MW

Trade Price = \$25.1365/MWh

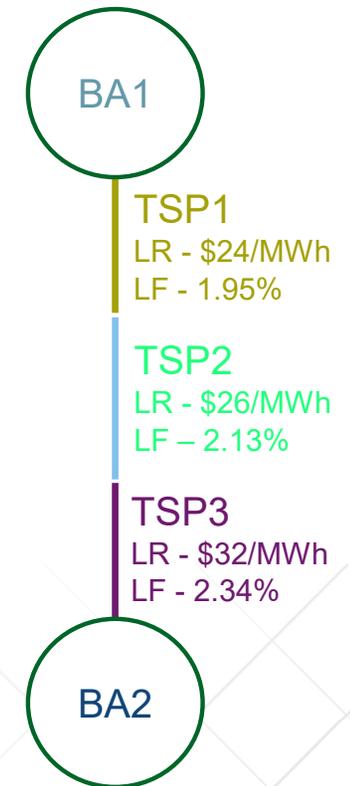
Settlement

- Buyer (Entity 2) owes Seller (Entity 1) for non-firm energy trade
 - $(\$25.1365/\text{MWh}) \times (48 \text{ MW}) / 4 \text{ periods per hour} = \301.638
- Seller (Entity 1) owes TSP1 and TSP2 for financial losses
 - $(\$24/\text{MWh}) \times (1.95\%) \times (48 \text{ MW}) / 4 \text{ periods per hour} = \5.616
 - $(\$26/\text{MWh}) \times (2.13\%) \times (48 \text{ MW}) / 4 \text{ periods per hour} = \6.6456
- Buyer (Entity 2) owes TSP3 for financial losses
 - $(\$32/\text{MWh}) \times (2.34\%) \times (48 \text{ MW}) / 4 \text{ periods per hour} = \8.9856

Benefit

- Buyer: Avoided Cost – Trade Costs = $\$(30 \times 48 / 4) - \$301.638 - \$8.9856$
 - \$49.3764
- Seller: Deal Revenue – Cost to Serve Sale =

$$\$301.638 - \$(20 \times 48 / 4) - \$5.616 - \$6.6456$$
 - \$49.3764



Entity 2 in BA2 – Buyer
Bid Price - \$30/MWh
Bid Volume - 48 MW

SEEM Data Flow

Inputs

Network Model – Source/Sink
POR/POD,
SEEM Segment, SEEM Path

Available NFEETS (MWs)

Financial Loss Rates (\$/MWh)
Loss Factors (%)

Bid Price, Volume, Sink,
Offer Price, Volume, Source,
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SEEM Platform (Hartigen)

User Interface/API:

- Enter/Modify input data
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Market Engine

- Runs every 15 minutes
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Outputs

TSR

e-Tag

15-Min Transaction Record
Counterparty, Volume/Price,
Buy/Sell Location, Start/Stop
Time, Path, Aref, Tag Code

Market Platform Output

- Transaction meets max market benefit/optimization objective
- Outputs
 - Buyer/Seller
 - Trade Location/Contract Path
 - Trade Price (\$/MWh)
 - Trade Volume (MW)
 - Financial Loss Cost per TSP (\$)
 - Monthly transaction report
 - OASIS TSR
 - OATI eTag

Questions

