Convergence Bidding Tutorial & Panel Discussion

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Convergence Basics

• Day-Ahead Market basics
• Day-Ahead and Real-Time Market interactions
• Increment offers (incs) and decrement bids (decs)
• Roles of incs and decs
• Examples
• Review of PJM results
• Issues
Two Energy Markets

• Day-Ahead Energy Market
  – Develop day-ahead schedule using least-cost security constrained unit commitment and dispatch
  – Calculate hourly LMPs for next operating day using generation offers, demand bids and bilateral transaction schedules
  – Objective is to develop set of financial schedules that are physically feasible

• Real-Time Energy Market
  – Calculate hourly LMPs based on actual system operating conditions
Day-Ahead Energy Market

- A Day-ahead hourly forward market for energy
- Provides the option to obtain increased certainty:
  - Purchase of MW at Day-ahead prices
  - Sale of MW at Day-ahead prices
  - Day-ahead congestion
- Price-sensitive demand
- Increment offers
- Decrement bids
- PJM Capacity Resources must submit offers
- Participation by load is optional
• Reserve adequacy assessment is designed to ensure adequate generating resources to meet forecast actual load in real time
• Additional generating resources scheduled after day-ahead market clears
• Based on PJM load forecast, physical generation assets, actual transaction schedules (net tie schedules) and full PJM operating reserve requirements
• Virtual bids and offers not included
• To preserve economic incentives, any additional unit commitment is based on minimizing cost to provide additional reserves (minimize startup and no-load costs)
Two Energy Market Settlements

• Day-Ahead Market Settlement
  – Based on scheduled hourly MW quantities and day-ahead LMPs

• Balancing Market Settlement
  – Based on hourly MW quantity deviations between real-time and day-ahead
  – MW quantity deviations settled at real-time LMPs
Day-Ahead Market Implications

- Day-ahead schedules are financially binding
- Demand scheduled day-ahead
  - Pays day-ahead LMP for day-ahead MW scheduled
  - Pays real-time LMP for actual MW above scheduled
  - Paid real-time LMP for actual MW below scheduled
- Generation scheduled day-ahead
  - Paid day-ahead LMP for day-ahead MW scheduled
  - Paid real-time LMP for actual MW above scheduled
  - Pays real-time LMP for actual MW below scheduled
Increment Offers & Decrement Bids

• Available to all Market Participants
• Do not require physical generation or load
• Consist of:
  – MW offer or bid
  – Price of offer or bid (may be negative)
• Submitted at any hub, transmission zone, aggregate, or single bus for which LMP is calculated
• Supported in Day-ahead market only
  – Deviation in Real-time market
• Operating Reserve Charge Implications
Increment Offers
• Looks like a spot sale or dispatchable resource
• “If the price goes above X, then I will sell to the day-ahead PJM spot market”

Decrement Bids
• Looks like spot purchase or price sensitive demand
• “If price goes below X then I will buy from the day-ahead PJM spot market”
Why Use an Inc or Dec?

- Cover one side of a bilateral transaction
- Cover eSchedules deal
  - allows opposite party access to real-time LMP while you participate in day-ahead
- Hedge a Day-ahead generation offer
  - Use a decrement bid
- Arbitrage Day-ahead to Real-time pricing
  - Use an increment offer or decrement bid
- Hedge Day-ahead Demand bid
Example #1 - Increment Offer

**Day-ahead**

- Participant offers 100 MW at $30
- Assume Day ahead LMP = $25
- Increment Offer does not clear
- Day-ahead position is 0

**Real-time**

- Increment Offer did not clear
- Balancing Settlement = 0 (no deviation)

Net position = 0
Example #2 - Increment Offer

**Day-ahead**

- Participant offers 100 MW at $30
- Assume Day ahead LMP = $35
- Day ahead Settlement = 100 MW * $35 = $3500 credit

**Real-time**

- Assume Real-time LMP = $20
- Deviation from DA schedule = -100 MW
- Balancing Settlement = -100 MW * $20 = $2000 charge

**Net position** = $3500 - $2000 = $1500 credit
Example #3 - Increment Offer

**Day-ahead**
- Participant offers 100 MW at $30
- Assume Day ahead LMP = $35
- Day ahead Settlement = 100 MW * $35 = $3500 credit

**Real-time**
- Assume Real-time LMP = $40
- Deviation from DA schedule = -100 MW
- Balancing Settlement = -100 MW * $40 = $4000 charge

Net position = $3500-$4000 = $500 charge
Example #1 - Decrement Bid

**Day-ahead**

- Participant bids 100 MW at $20
- Assume Day ahead LMP= $25
- Decrement bid does not clear
- Day-ahead position is 0

**Real-time**

- Decrement bid did not clear
- Balancing Settlement = 0 (no deviation)

Net position = 0
Example #2 - Decrement Bid

**Day-ahead**

- Participant bids 100 MW at $20
- Assume Day ahead LMP = $15
- Day ahead Settlement = 100 MW * $15 = $1500 charge

**Real-time**

- Assume Real-time LMP = $25
- Deviation from DA schedule = 100 MW
- Balancing Settlement = 100 MW * $25 = $2500 credit

**Net position** = -$1500 + $2500 = $1000 credit
**Example #3 - Decrement Bid**

- **Day-ahead**
  - Participant bids 100 MW at $20
  - Assume Day ahead LMP = $15
  - Day ahead Settlement = 100 MW * $15 = $1500 charge

- **Real-time**
  - Assume Real-time LMP = $10
  - Deviation from DA schedule = 100 MW
  - Balancing Settlement = 100 MW * $10 = $1000 credit

**Net position** = -$1500 + $1000 = $500 charge
Self-scheduled generator (200 MW) wants to see Real-time pricing

**Day-ahead**

Generator self-schedules unit at 200MW
Decreased bid at same bus for 200 MW at $100
Assume Day ahead LMP= $30
Day ahead Settlement (Gen) = 200 MW * $30 = $6000 credit

**Real-time**

Assume Generator produces 200 MW
Assume Real-time LMP = $35
Deviation from DA schedule (Gen) = 0 MW
Deviation from DA schedule (Dec) = 200 MW
Balancing Settlement (Gen) = 0 MW * $35 = 0
Balancing Settlement (Dec) = 200 MW * $35 = $7000 credit

Net Day ahead Position = 0

Net position = 0 + $7000 = $7000 credit
Internal Bilateral – Seller wants RT Pricing, Buyer wants DA pricing

**Day-ahead Buyer**

100 MW Transaction entered as DA in eSchedules

Assume Day ahead LMP = $40

Day ahead Settlement (Purchase) = 100 MW * $40 = $4000 credit

Net Day ahead Position = $4000

**Real-time Buyer**

100 MW transaction carries over to RT

Assume Real-time LMP = $50

Deviation from DA schedule (Sale) = 0 MW

Balancing Settlement (Sale) = 0 MW * $50 = $0

Balancing Position = $0

Net position = $4000 + $0 = $4000 credit
Internal Bilateral – Seller wants RT Pricing, Buyer wants DA pricing

**Day-ahead Seller**

100 MW Transaction entered as DA in eSchedules
Seller enters Increment offer at same location for 100 MW at low price

- Assume Day ahead LMP = $40
- Day ahead Settlement (Inc) = 100 MW * $40 = $4000 credit
- Day ahead Settlement (Sale) = 100 MW * $40 = $4000 charge

*Net Day ahead Position = 0*

**Real-time Seller**

100 MW transaction carries over to RT

- Assume Real-time LMP = $50
- Deviation from DA schedule (INC) = -100 MW
- Deviation from DA schedule (Sale) = 0 MW

- Balancing Settlement (INC) = -100 MW * $50 = $5000 charge
- Balancing Settlement (Sale) = 0 MW * $50 = $0

*Balancing Position = $5000 charge*

Net position = 0 + $5000 = $5000 charge
Generator in danger of a forced reduction in real-time (i.e. mech. Failure)

**Day-ahead Generator**

200 MW Scheduled Generation
Dec bid 100 MW @ $20

Assume Day ahead LMP = $15

Day ahead Settlement (Gen) = 200 MW * $15 = $3000 credit

Day ahead Settlement (DEC) = 100 MW * $15 = $1500 charge

Net Day ahead Position = 1500 credit

**Real-time Generator**

Generator produces 100 MW

Assume Real-time LMP = $20

Deviation from DA schedule (GEN) = -100 MW

Deviation from DA schedule (DEC) = 100 MW

Balancing Settlement (GEN) = -100 MW * $20 = $2000 charge

Balancing Settlement (DEC) = 100 MW * $20 = $2000 credit

Balancing Position = $0

Net position = $1500 + $0 = $1500 credit

Without DEC
Net credit = $1000
Example - Hedge Day-ahead Demand Bid

Demand bid hedged with a Decrement Bid

Day-ahead Demand

100 MW Scheduled Demand
Dec bid 20 MW @ $20
Assume Day ahead LMP= $15
Day ahead Settlement (Demand) = 100 MW * $15 = $1500 charge
Day ahead Settlement (DEC) = 20 MW * $15 = $300 charge
Net Day ahead Position = 1800 charge

Real-time Demand

Real-time Demand = 110 MW
Assume Real-time LMP = $20
Deviation from DA schedule (DEMAND) = 10 MW
Deviation from DA schedule (DEC) = 20 MW
Balancing Settlement (DEMAND) = 10 MW * $20 = $200 charge
Balancing Settlement (DEC) = 20 MW * $20 = $400 credit
Balancing Position = $200 credit

Net position = $1800 - $200 = $1600 charge

Without DEC
Net charge = $1700
Day-ahead and Real-time Generation: 2005

- **Day-ahead generation**
- **Real-time generation**
- **Day-ahead generation plus increment offers**

Graph showing the volume (in MWh) from 6:00 AM to 11:00 PM with three lines representing different generation types.
Day-ahead and Real-time Loads: 2005
RTO Convergence – Monthly Mean and Absolute Value

The chart illustrates the trend of RTO Convergence (Monthly Mean and Absolute Value) over time from January 2001 to March 2006. It shows the fluctuations in RTO values, with a line graph depicting the monthly mean and another line representing the absolute value of the difference between RTO and the baseline (RTLMP-DALMP). The data points are marked with specific months, indicating the volatility and changes in RTO values throughout the specified period.
PJM Hourly System Average LMP: 2005

The graph shows the comparison between the Day-Ahead Energy Market (orange line) and the Real-Time Energy Market (blue line) for hourly system average LMP (Locational Marginal Price) in 2005. The prices are displayed on the vertical axis, ranging from $0 to $90, while the hours of the day are shown on the horizontal axis, from 1 to 24 hours ending (EPT). The graph indicates the highest prices during the afternoon hours, with a peak around 17 hours ending (EPT).
Zonal Convergence – Absolute Value
Bus convergence: Mean and Standard Deviation
Convergence Issues

• Market power issues
  – Ability to create congestion in day-ahead market
  – Ability to make FTRs more valuable
• Rule to address this issue is in PJM Operating Agreement
• Limits on level of increment offers and decrement bids
  – PJM does not currently have limits
  – Should be considered
• Credit requirements
  – PJM has credit requirements for participation