Locational Based Marginal Pricing

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New York Market Orientation Course (NYMOC)

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Benefits to Understanding

- Locational Based Marginal Pricing
  - Your Business Decisions
    • Be better informed for your bidding, forecasting, and investing decisions through understanding the price signals being sent
  - Your Financial Results
    • Understanding payments and charges on your invoice
Locational Based Marginal Pricing

SESSION OBJECTIVES:

• Understand the Basics Behind LBMP
  • Definition
  • Show how LBMPs are Established
  • Name the Three Components of LBMP
• Complete Examples that Demonstrate LBMP Concepts
LBMP - Defined

- A methodology where the price of Energy at each location in the NYS Transmission System/NYCA is equivalent to the cost to supply the next increment of Load at that location.

- The cost to provide the next MW of Load at a specific location in the grid is the Marginal Price (LBMP)
LBMP – The Basics

- LBMP is established for the Day Ahead and the Real Time Markets
  - Day Ahead Market
    - Security Constrained Unit Commitment (SCUC)
    - Hourly Prices
  - Real Time Market
    - Real Time Dispatch (RTD)
    - 5 Minute Interval Prices
LBMP: Co-Optimized Based on Bids and Offers

INPUT-
BIDS AND OFFERS

NYISO Forecast
Load Bids
Generator Offers
Transactions
Ancillary Services
Virtuals
Demand Response
Constraints

NYISO SCUC/RTD

CO-OPTIMIZATION FOR LOWEST TOTAL PRODUCTION COST$

OUTPUT-
SCHEDULES
+
PRICES
LBMP - Established

- System is bid-based
  - Offers/Bids are Confidential
  - LBMPs are published, keeping market visible
LBMP – Established Summary

- System establishes load
- Generation offers evaluated
- Transmission Constraints taken into account
- Economic generation dispatched
- Cost of Next MW of Load - Market Clearing Price
LBMP Components

- Three Components Comprise the LBMP
  - Marginal Energy Price Component
  - Marginal Loss Price Component
  - Marginal Congestion Price Component
LBMP Components - Energy

- Marginal Energy Price Component
  - Basic component of the LBMP at all buses in system – NYISO Reference Bus (Marcy), posted on NYISO site as: “NYISO_LBMP_Reference”
LBMP Components - Losses

- Marginal Loss Price Component
  - Some amount of generation will be lost along path to load due to heat dissipation
    - Transmission Losses
    - Approx. 2.5% of Energy is consumed by Losses in NYCA
  - Marginal Loss Component takes this into account
  - If Losses were zero, Loss $ Component would be zero as well
**LBMP Components - Losses**

- **Marginal Loss Price Component**
  - Factors used to determine losses
    - Delivery Factor
    - Energy Price Component at NYISO Reference Bus
  - Delivery Factor
    - Impact on Overall System Losses (+/-) when power injected at a Specific Generator Bus
- **System Losses and Loss Component**
  - If a MW injected at a bus reduces system Losses - $ Loss Component of LBMP increases-(greater value)
LBMP Components - Losses

- Marginal Loss Price Component
  - For Detailed Information see OATT Attachment J or MST Attachment B
  - Market Participant User’s Guide 3.3.1
LBMP Components - Congestion

- Marginal Congestion Price Component
  - In some instances, dispatching least costly generation may exceed line limitations
  - More costly units may subsequently be dispatched to avoid exceeding those limits
LBMP Components - Congestion

Total Load
100 MW
LBMP Components - Congestion

Gen 1 can Supply 110 MW @ $20/MW

Total Load 100 MW

Gen 2 can Supply 100 MW @ $50/MW
LBMP Components - Congestion

Gen 1 can Supply
110 MW @ $20/MW

Gen 2 can Supply
100 MW @ $50/MW

Total Load
100 MW
LBMP Components - Congestion

- Marginal Congestion Price Component
  - Difference between 2 marginal prices creates congestion component
# LBMP-Three Components, An Analogy

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Generators – Gen Bus LBMP

- LBMP for Generators
  - Based on Generator Bus
  - LBMP calculated at Bus where Generator injects power
Load Serving Entity – Zonal LBMP

- LBMP for Load
  - Based on Zone where Load is Located
  - One Zonal LBMP for entire Zone
  - Load Weighted Average

**NYCA Load Zones**

- A- West
- B- Genesee
- C- Central
- D- North
- E- Mohawk Valley
- F- Capital
- G- Hudson Valley
- H- Millwood
- I- Dunwoodie
- J- NYC
- K- Long Island

**Regional Zones**

- ISO-NE
- IESO
- PJM

**Map showing zones**
Example 1: Energy Only
No Losses and No Congestion

Total Load = 150 MW
Example 1: Energy Only

Gen ‘Power Up’
100 MW, Bid @$20/MW

Gen ‘Full Steam’
150 MW, Bid @$35/MW

Gen ‘Energy’
100 MW, Bid @$30/MW

Gen ‘Lights On’
200 MW, Bid @$40/MW

Limit
150 MW

Total Load
150 MW

West Zone
Load A
30 MW

East Zone
Load B
120 MW
Example 1: Energy Only

- **Gen ‘Power Up’**
  - 100 MW, Bid @$20/MW
- **Gen ‘Full Steam’**
  - 150 MW, Bid @$35/MW
- **Gen ‘Energy’**
  - 100 MW, Bid @$30/MW
- **Gen ‘Lights On’**
  - 200 MW, Bid @$40/MW

**Limit**: 150 MW

**Total Load**: 150 MW

- **West Zone**
  - Load A
  - 30 MW
- **East Zone**
  - Load B
  - 120 MW
Example 1: Energy Only

Gen ‘Power Up’
100 MW, Bid @$20/MW

Gen ‘Full Steam’
150 MW, Bid @$35/MW

Gen ‘Energy’
100 MW, Bid @$30/MW

Gen ‘Lights On’
200 MW, Bid @$40/MW

Limit
150 MW

Total Load
150 MW

West Zone
Load A
30 MW

East Zone
Load B
120 MW
Example 1: Energy Only

Gen ‘Power Up’
100 MW, Bid @$20/MW

Gen ‘Full Steam’
150 MW, Bid @$35/MW

Gen ‘Energy’
100 MW, Bid @$30/MW

Gen ‘Lights On’
200 MW, Bid @$40/MW

100 MW

30 MW

70 MW

Limit
150 MW

Total Load
150 MW

East Zone
Load B
120 MW

West Zone
Load A
30 MW

FOR TRAINING PURPOSES ONLY
Example 1: Energy Only - Results

- **Gen ‘Power Up’**
  - 100 MW, Bid @$20/MW

- **Gen ‘Full Steam’**
  - 150 MW, Bid @$35/MW

- **Gen ‘Energy’**
  - 100 MW, Bid @$30/MW

- **Gen ‘Lights On’**
  - 200 MW, Bid @$40/MW

- **Total Load**: 150 MW
- **Limit**: 150 MW

**West Zone**
- Load A: 30 MW
- LBMP: $30.00

**East Zone**
- Load B: 120 MW
- LBMP: $30.00

---

Energy Loss: $0.00
Congestion: $30.00
West Zone LBMP: $30.00
East Zone LBMP: $30.00
Example 1: Energy Only - Results

- Gen ‘Power Up’, 100 MW
  - Bid $20, Paid $20

- Gen ‘Full Steam’, 150 MW
  - Bid $35, Paid $0

- Gen ‘Energy’, 100 MW
  - Bid $30, Paid $30

- Gen ‘Lights On’, 200 MW
  - Bid $40, Paid $0

Generators receive $30/MW (LBMP)
Example 1: Energy Only - Results

Loads Charged $30/MW (LBMP)

West Zone
Load A
30 MW

East Zone
Load B
120 MW
Example 2: Energy Only
No Losses and No Congestion

Total Load = 200 MW
Example 2: Energy Only

- **Gen ‘Power Up’**
  - 100 MW, Bid @$30/MW

- **Gen ‘Full Steam’**
  - 200 MW, Bid @$50/MW

- **Gen ‘Energy’**
  - 150 MW, Bid @$40/MW

- **Gen ‘Lights On’**
  - 150 MW, Bid @$35/MW

---

**West Zone**
- Load A
  - 50 MW

**East Zone**
- Load B
  - 150 MW

**Total Load**
- 200 MW

**Limit**
- 150 MW
Example 2: Energy Only

- **Gen ‘Power Up’**
  - 100 MW, Bid @ $30/MW

- **Gen ‘Full Steam’**
  - 200 MW, Bid @ $50/MW

- **Gen ‘Energy’**
  - 150 MW, Bid @ $40/MW

- **Gen ‘Lights On’**
  - 150 MW, Bid @ $35/MW

Total Load: 200 MW

Limit: 150 MW

West Zone
- Load A
  - 50 MW

East Zone
- Load B
  - 150 MW
Example 2: Energy Only

**Gen ‘Power Up’**
100 MW, Bid @$30/MW

**Gen ‘Full Steam’**
200 MW, Bid @$50/MW

**Gen ‘Energy’**
150 MW, Bid @$40/MW

**Gen ‘Lights On’**
150 MW, Bid @$35/MW

Total Load: 200 MW

Limit: 150 MW

West Zone
Load A
50 MW

East Zone
Load B
150 MW
Example 2: Energy Only

- **Gen ‘Power Up’**
  - 100 MW, Bid @$30/MW

- **Gen ‘Full Steam’**
  - 200 MW, Bid @$50/MW

- **Gen ‘Energy’**
  - 150 MW, Bid @$40/MW

- **Gen ‘Lights On’**
  - 150 MW, Bid @$35/MW

- **Limit**
  - 150 MW

- **Total Load**
  - 200 MW

- **West Zone**
  - Load A
    - 50 MW

- **East Zone**
  - Load B
    - 150 MW
Example 2: Energy Only - Results

- **Gen ‘Power Up’**
  - 100 MW, Bid @$30/MW

- **Gen ‘Full Steam’**
  - 200 MW, Bid @$50/MW

- **Gen ‘Energy’**
  - 150 MW, Bid @$40/MW

- **Gen ‘Lights On’**
  - 150 MW, Bid @$35/MW

**Total Load**: 200 MW

**Limit**: 150 MW

- **West Zone**
  - Load A: 50 MW
  - LBMP: $35.00
  - Energy: $35.00
  - Loss: $0.00
  - Congestion: -$0.00

- **East Zone**
  - Load B: 150 MW
  - LBMP: $35.00
  - Energy: $35.00
  - Loss: -$0.00
  - Congestion: -$0.00

**West Zone LBMP**: $35.00

**East Zone LBMP**: $35.00
Example 2: Energy Only - Results

- **Gen ‘Power Up’, 100 MW**
  - Bid: $30, Paid: $35

- **Gen ‘Full Steam’, 200 MW**
  - Bid: $50, Paid: $0

- **Gen ‘Energy’, 150 MW**
  - Bid: $40, Paid: $0

- **Gen ‘Lights On’, 150 MW**
  - Bid: $35, Paid: $35

Generators receive $35/MW (LBMP)
Example 2: Energy Only - Results

Loads Charged $35/MW (LBMP)

West Zone
Load A
50 MW

East Zone
Load B
150 MW
Congestion

Congestion occurs when the Power flow reaches the Transmission Limit

At Limit Congestion
Congestion

- To maintain efficient and reliable Transmission system
  - Transmission limits cannot be exceeded
  - When Transmission limits reached, generators from different buses are dispatched to meet load

- When there is congestion, LBMPs can differ between buses
Contributing Congestion Factors

- Generator Derates
- Line Outages
- Transaction Curtailments
- TSA – Severe Weather Conditions
- Reserve Shortage
- Alert State
- OOM & SRE Request
- Forecast Load vs. Actual RT Load
Example 3: Energy and Congestion, No Losses

Total Load = 400 MW
Example 3: Energy and Congestion

**Gen ‘Power Up’**
310 MW, Bid @$30/MW

**Gen ‘Full Steam’**
350 MW, Bid @$40/MW

**Gen ‘Energy’**
100 MW, Bid @$25/MW

**Gen ‘Lights On’**
350 MW, Bid @$35/MW

---

Total Load: 400 MW
Limit: 150 MW

West Zone
Load A
40 MW

East Zone
Load B
360 MW
Example 3: Energy and Congestion

Gen ‘Power Up’
310 MW, Bid @$30/MW

Gen ‘Full Steam’
350 MW, Bid @$40/MW

Gen ‘Energy’
100 MW, Bid @$25/MW

Gen ‘Lights On’
350 MW, Bid @$35/MW

Total Load
400 MW

Limit
150 MW

Limit
150 MW

West Zone
Load A
40 MW

East Zone
Load B
360 MW
Example 3: Energy and Congestion

- **Gen ‘Power Up’**
  - 310 MW, Bid @$30/MW
- **Gen ‘Full Steam’**
  - 350 MW, Bid @$40/MW
- **Gen ‘Energy’**
  - 100 MW, Bid @$25/MW
- **Gen ‘Lights On’**
  - 350 MW, Bid @$35/MW

- **Total Load**: 400 MW
- **Limit**: 150 MW
- **West Zone**
  - Load A: 40 MW
- **East Zone**
  - Load B: 360 MW
Example 3: Energy and Congestion

- **Gen ‘Power Up’**
  - Power: 310 MW
  - Bid: $30/MW

- **Gen ‘Full Steam’**
  - Power: 350 MW
  - Bid: $40/MW

- **Gen ‘Energy’**
  - Power: 100 MW
  - Bid: $25/MW

- **Gen ‘Lights On’**
  - Power: 350 MW
  - Bid: $35/MW

**Limit**: 150 MW

**Total Load**: 400 MW

- **West Zone**
  - Load A: 40 MW
- **East Zone**
  - Load B: 360 MW
Example 3: Energy and Congestion

Gen ‘Power Up’
310 MW, Bid @$30/MW

Gen ‘Full Steam’
350 MW, Bid @$40/MW

Gen ‘Energy’
100 MW, Bid @$25/MW

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350 MW, Bid @$35/MW

Total Load
400 MW

West Zone
Load A
40 MW

East Zone
Load B
360 MW

Limit
150 MW
Example 3: Energy and Congestion

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Total Load
400 MW

Limit
150 MW

West Zone
Load A
40 MW

East Zone
Load B
360 MW
Example 3: Energy and Congestion - Results

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310 MW, Bid @$30/MW

Gen ‘Full Steam’
350 MW, Bid @$40/MW

Gen ‘Energy’
100 MW, Bid @$25/MW

Gen ‘Lights On’
350 MW, Bid @$35/MW

Total Load
400 MW

Limit
150 MW

West Zone LBMP $30.00

East Zone LBMP $35.00
Example 3: Energy and Congestion - Results

Gen 'Power Up', 310 MW
Bid $30, Paid $30

Gen 'Full Steam', 350 MW
Bid $40, Paid $0

Gen 'Energy', 100 MW
Bid $25, Paid ?

Gen 'Lights On', 350 MW
Bid $35, Paid ?

Generator “Power Up" receives $30/MW (LBMP)
Example 3: Energy and Congestion - Results

Generators, East of the interface receive $35/MW (LBMP)
Example 3: Energy and Congestion - Results

Loads in West Zone
Charged $30/MW (LBMP)

West Zone
Load A
40 MW

Loads in East Zone
Charged $35/MW (LBMP)

East Zone
Load B
360 MW
Day Ahead LBMP- Zonal pattern for 1 hour

Zonal Day-Ahead Market LBMP
HB 14 07/08/13

- Energy
- Losses
- Congestion

- A-West
- B-Genesee
- C-Central
- D-North
- E-MV
- F-Capital
- G-HV
- H-Millwd
- I-Dunw
- J-NYC
- K-LI
Example 4: Energy and Congestion, No Losses

Total Load = 300 MW
Example 4: Energy and Congestion

Gen ‘Power Up’
110 MW, Bid @$40/MW

Gen ‘Full Steam’
100 MW, Bid @$30/MW

Gen ‘Energy’
100 MW, Bid @$35/MW

Gen ‘Lights On’
150 MW, Bid @$50/MW

Total Load
300 MW

Limit
150 MW

West Zone
Load A
20 MW

East Zone
Load B
280 MW
Example 4: Energy and Congestion – Results

- Gens in West paid LBMP @ Bus 1 & 2
  - ? MW
  - $/?/MW
  - ? MW x $?
  - $
  - Total Paid

- Gens in East paid LBMP @ Bus 3 & 4
  - ? MW
  - $/?/MW
  - ? MW x $?
  - $
  - $?

- Load A in West pays West Zone LBMP
  - ? MW
  - $/?/MW
  - ? MW x $?
  - $
  - Total Charged

- Load B in East pays East Zone LBMP
  - ? MW
  - $/?/MW
  - ? MW x $?
  - $
  - $?

$? Difference = Congestion Rent
### LBMP Components on the NYISO website

**Day Ahead Market Zonal LBMP**

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**LBMP Components**

- **Loss**: 27.54, 0.83, -14.55
- **Congestion**: 13.94, 0.27, -1.55
- **NYISO_LBMP_REFERENCE**: 12.16, 0.00, 0.00
Let’s Review

LBMP is the cost to provide the
a) Exact MW of Load at a specific location in grid
b) Next MW of Load at a specific location in grid

LBMP is established through
a) Economic Dispatch process
b) Random Generation Selection Process

LBMP is comprised of
a) One Single Price Component
b) Three Separate Price Components
Let’s Review

Posted Prices are
a) Visible on an individual and confidential basis
b) Visible to the public on NYISO’s website

LBMP for Load is
a) Established at each LSE’s location
b) Established at a Zonal level

LBMP for Generator is
a) Established at a Zonal level
b) Established at the Generator Bus
Locational Based Marginal Pricing

SESSION OBJECTIVES:

• Understand the Basics Behind LBMP
  • Definition
  • Show how LBMPs are Established
  • Name the Three Components of LBMP
• Complete Examples that Demonstrate LBMP Concepts
Additional Resources

- Tariffs - OATT & MST
- Day Ahead Scheduling Manual
- Transmission and Dispatching Operations Manual
- Market Participant User’s Guide
- Technical Bulletins