Locational Based Marginal Pricing

Mathangi Srinivasan
Senior Market Trainer, Market Training, NYISO

Market Overview Course
September 19th, 2019
Rensselaer, NY

Locational Based Marginal Pricing

- Attendees will be able to
  - Explain the Basics Behind LBMP
  - Complete Simple LBMP Examples
  - Identify the Impacts of Congestion
LBMP – The Basics

- LBMP is the Cost to provide the Next MW of Load at a Specific Location in the grid.

- LBMP is established for the Day Ahead Market and the Real Time Market:
  - 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**

**OUTPUT**

- SCHEDULES AND PRICES

**CO-OPTIMIZATION FOR LOWEST TOTAL PRODUCTION COST$**

---

**LBMP – The Basics**

- LBMP is made up of three components:
  - Marginal Energy Price
    - Basic Component of LBMP, calculated at Marcy
  - Marginal Loss Price
    - Captures Losses along path to Load
      - Transmission Losses
  - Marginal Congestion Price
    - Costlier units Dispatched to avoid exceeding Transmission Limits

**LBMP = Energy + Loss - Congestion**
Determining the Marginal Energy Price

- Price ($)
- MW
- Marginal Cost of Energy
- Gen 1
- Gen 2
- Gen 3
- Gen 4

Determining the Marginal Congestion Price

- Price ($)
- MW
- Transmission Line Limit
- Demand+1
- Congestion
- Gen 5
LBMP - Congestion

- Marginal Congestion Price Component
  - Difference between 2 marginal prices creates congestion component

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**

<table>
<thead>
<tr>
<th>Zone</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>West</td>
</tr>
<tr>
<td>B</td>
<td>Genesee</td>
</tr>
<tr>
<td>C</td>
<td>Central</td>
</tr>
<tr>
<td>D</td>
<td>North</td>
</tr>
<tr>
<td>E</td>
<td>Mohawk Valley</td>
</tr>
<tr>
<td>F</td>
<td>Capital</td>
</tr>
<tr>
<td>G</td>
<td>Hudson Valley</td>
</tr>
<tr>
<td>H</td>
<td>Millwood</td>
</tr>
<tr>
<td>I</td>
<td>Dunwoodie</td>
</tr>
<tr>
<td>J</td>
<td>NYC</td>
</tr>
<tr>
<td>K</td>
<td>Long Island</td>
</tr>
</tbody>
</table>

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 - Results

West Zone

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

Energy
$30.00
Loss
$0.00
Compression
-$30.00

West Zone Load A
30 MW

Total Load
150 MW

Limit
150 MW

East Zone

Load B
120 MW

East Zone LBMP $30.00

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

Congestion
Congestion occurs when the Power flow reaches the Transmission Limit

CONGESTION!!!
Transmission Line Limit
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

Example 2: Energy and Congestion

No Losses

Total Load
400 MW
Example 2: 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

West Zone
Load A
40 MW

Limit
150 MW

East Zone
Load B
360 MW

Total Load
400 MW

Example 2: 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

West Zone
Load A
40 MW

Limit
150 MW

East Zone
Load B
360 MW

Total Load
400 MW
Example 2: 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

Limit
150 MW

West Zone
Load A
40 MW

Total Load
400 MW

East Zone
Load B
360 MW

Example 2: 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

Limit
150 MW

West Zone
Load A
40 MW

Total Load
400 MW

East Zone
Load B
360 MW
Example 2: Energy and Congestion

<table>
<thead>
<tr>
<th>Generator</th>
<th>Capacity (MW)</th>
<th>Bid Price ($/MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen ‘Power Up’</td>
<td>310</td>
<td>@$30/MW</td>
</tr>
<tr>
<td>Gen ‘Full Steam’</td>
<td>350</td>
<td>@$40/MW</td>
</tr>
<tr>
<td>Gen ‘Energy’</td>
<td>100</td>
<td>@$25/MW</td>
</tr>
<tr>
<td>Gen ‘Lights On’</td>
<td>350</td>
<td>@$35/MW</td>
</tr>
</tbody>
</table>

Total Load: 400 MW

Limit: 150 MW

West Zone Load A: 40 MW

East Zone Load B: 360 MW
Example 2: Energy and Congestion - Results

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
West Zone LBMP $30.00

East Zone
Load B
360 MW
East Zone LBMP $35.00

Example 2: 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 2: Energy and Congestion - Results

Generators, East of the interface receive $35/MW (LBMP)

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 $35

Gen ‘Lights On’, 350 MW
Bid $35, Paid $35

Example 2: 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

Loads in the West Zone:
Load A: 40 MW

Loads in the East Zone:
Load B: 360 MW
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

LBMP is comprised of?
 a) One Single Price Component
 b) Three Separate Price Components

Let’s Review

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

LBMP for a Generator is?
 a) Established at a Zonal level
 b) Established at the Generator Bus
Additional Resources

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