

Locational Based Marginal Pricing

Gina Craan

Manager, Market Training, NYISO

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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

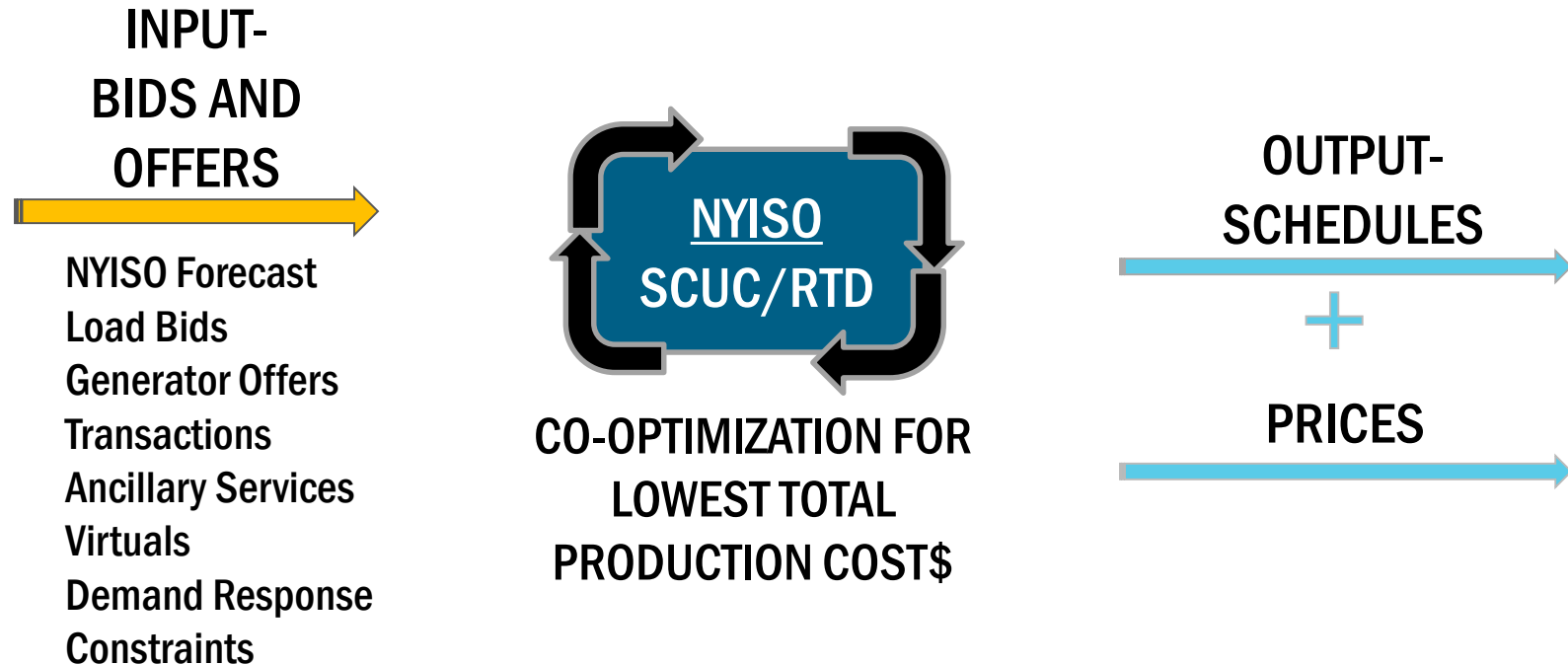
- A methodology where the price of Energy at each location in the NYS Transmission System/NYCA is equivalent to the cost to supply the next increment of Load at that location.
- The cost to provide the next MW of Load at a specific location in the grid is the Marginal Price (LBMP)

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



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

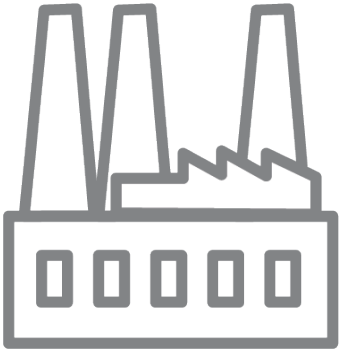
- **Marginal Congestion Price Component**
 - In some instances, dispatching least costly generation may exceed line limitations
 - More costly units may subsequently be dispatched to avoid exceeding those limits

LBMP Components - Congestion

Total Load
100 MW



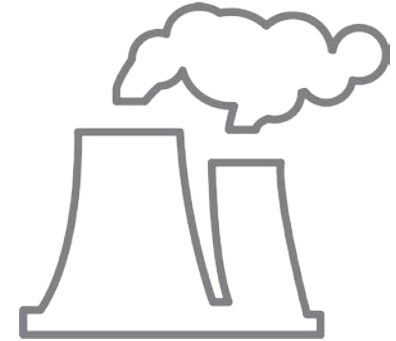
LBMP Components - Congestion



Gen 1 can Supply
110 MW @ \$20/MW

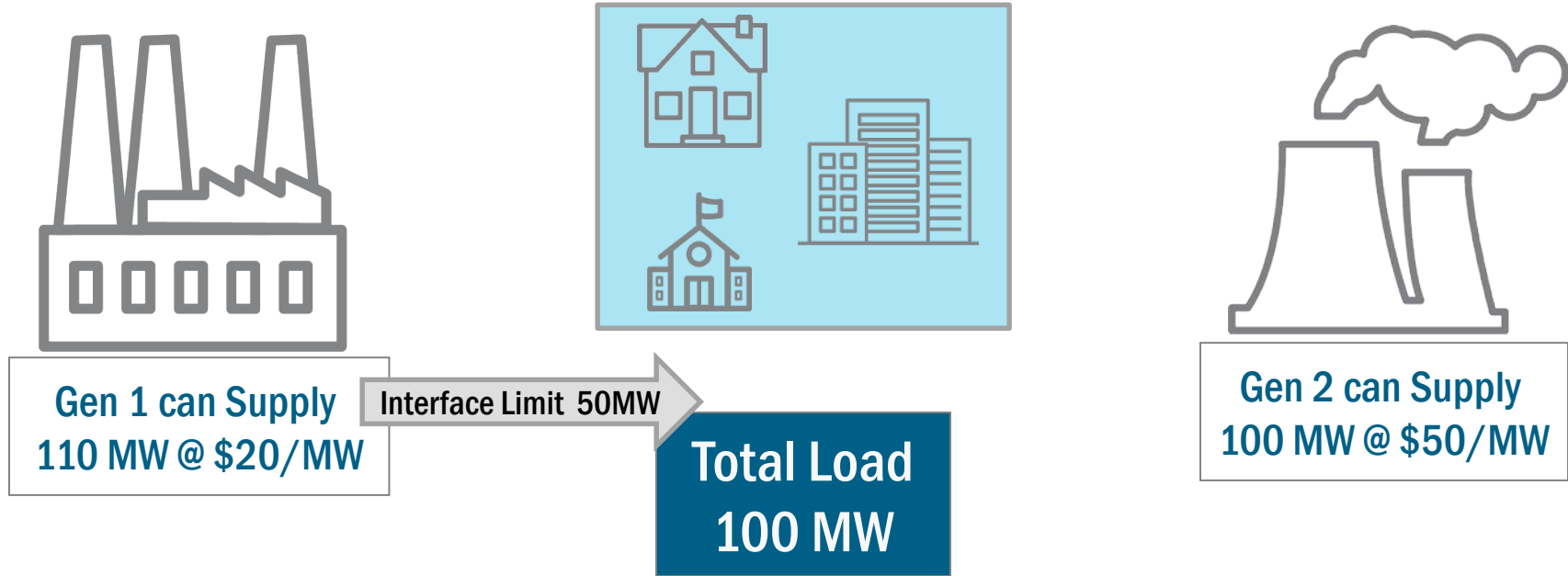


Total Load
100 MW



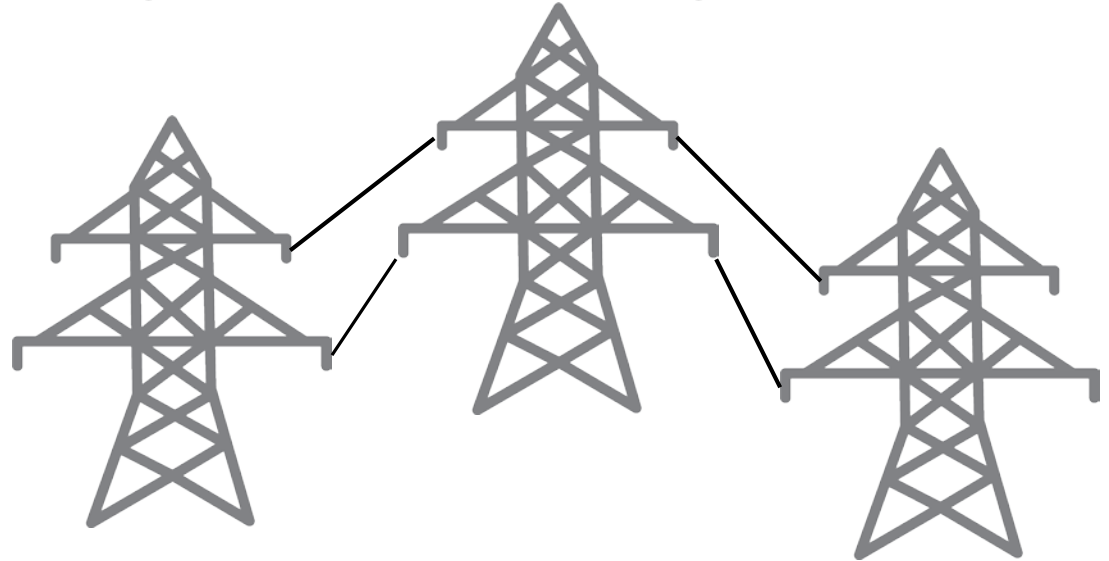
Gen 2 can Supply
100 MW @ \$50/MW

LBMP Components - Congestion

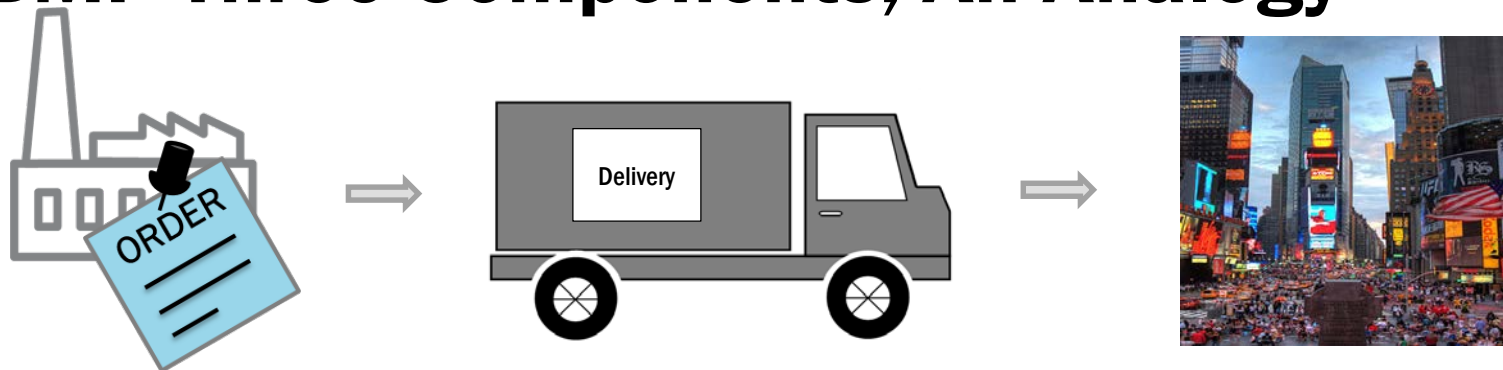


LBMP Components - Congestion

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



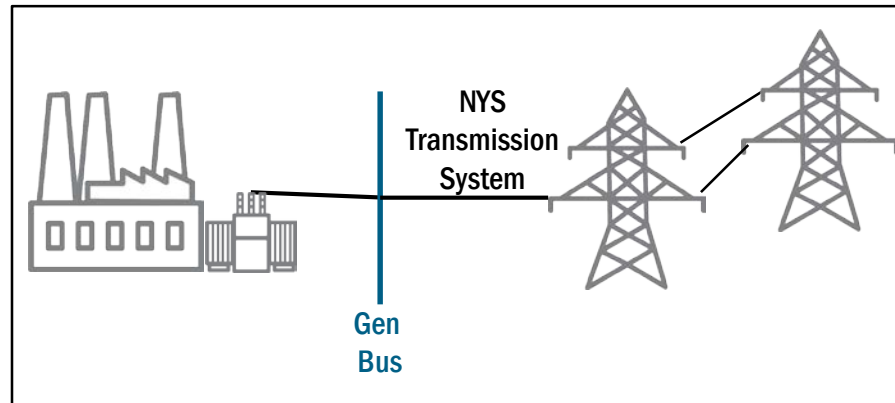
LBMP-Three Components, An Analogy



| Associated Cost | \$ Amount Capital -Zone F | \$ Amount NYC - Zone J | Similar to |
|--|------------------------------|---------------------------|---|
| Base price to make Billboard (cost to manufacture sign) | \$40 | \$40 | Energy Price Component (cost to produce power) |
| Shipping and Handling (cost to deliver the billboard) | \$2 | \$1 | Loss Price Component (cost to get energy to destination) |
| Potential for added cost (cost to purchase/rent a location) | \$20 | \$45 | Congestion Price Component (cost to ensure load need is met) |
| Total Cost for Product | \$62 | \$86 | LBMP |

Generators – Gen Bus LBMP

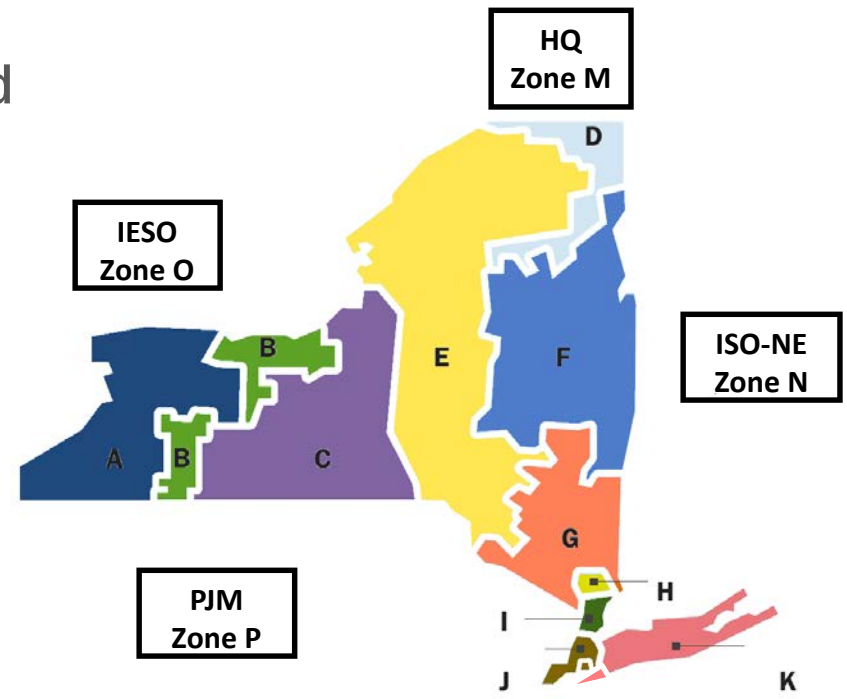
- LBMP for Generators
 - Based on Generator Bus
 - LBMP calculated at Bus where Generator injects power



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



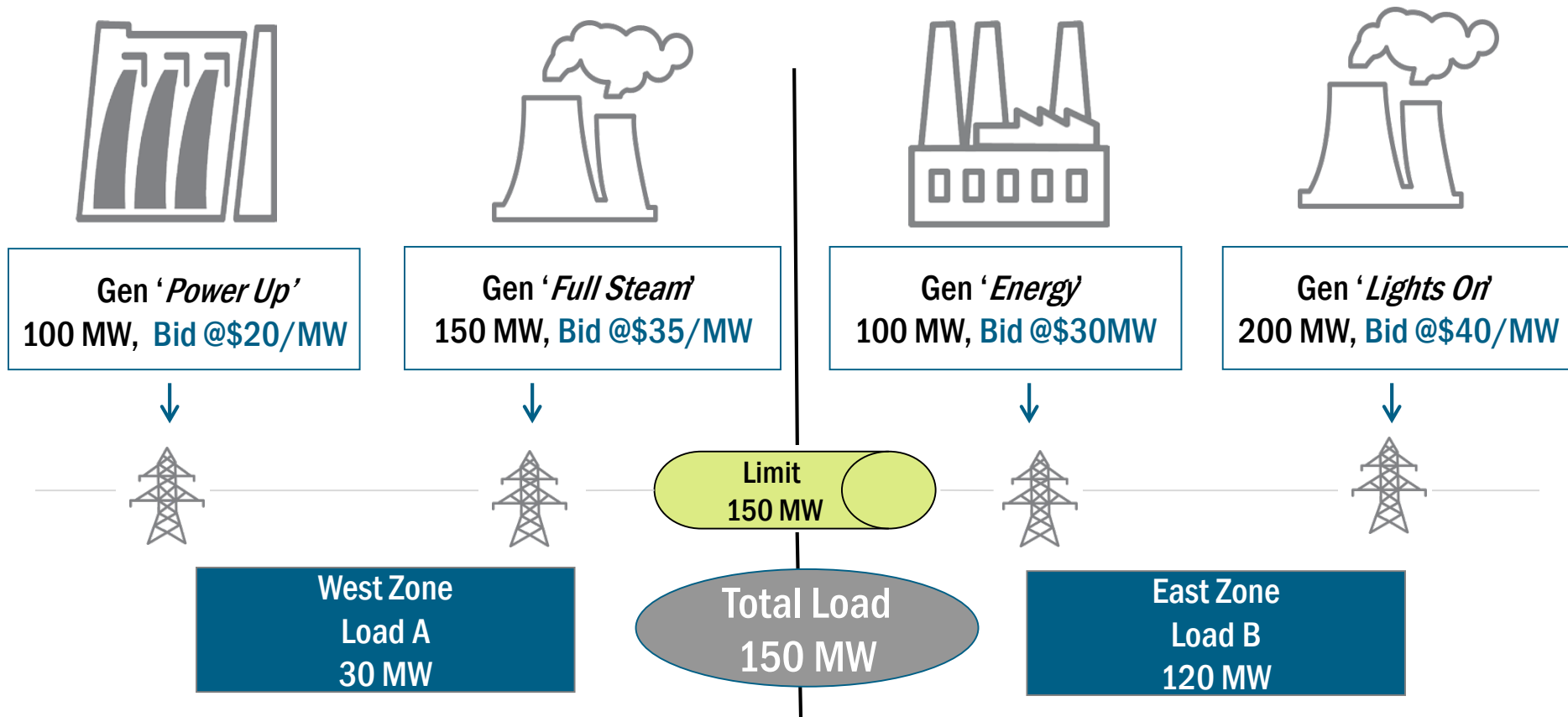
Example 1: Energy Only

No Losses and No Congestion

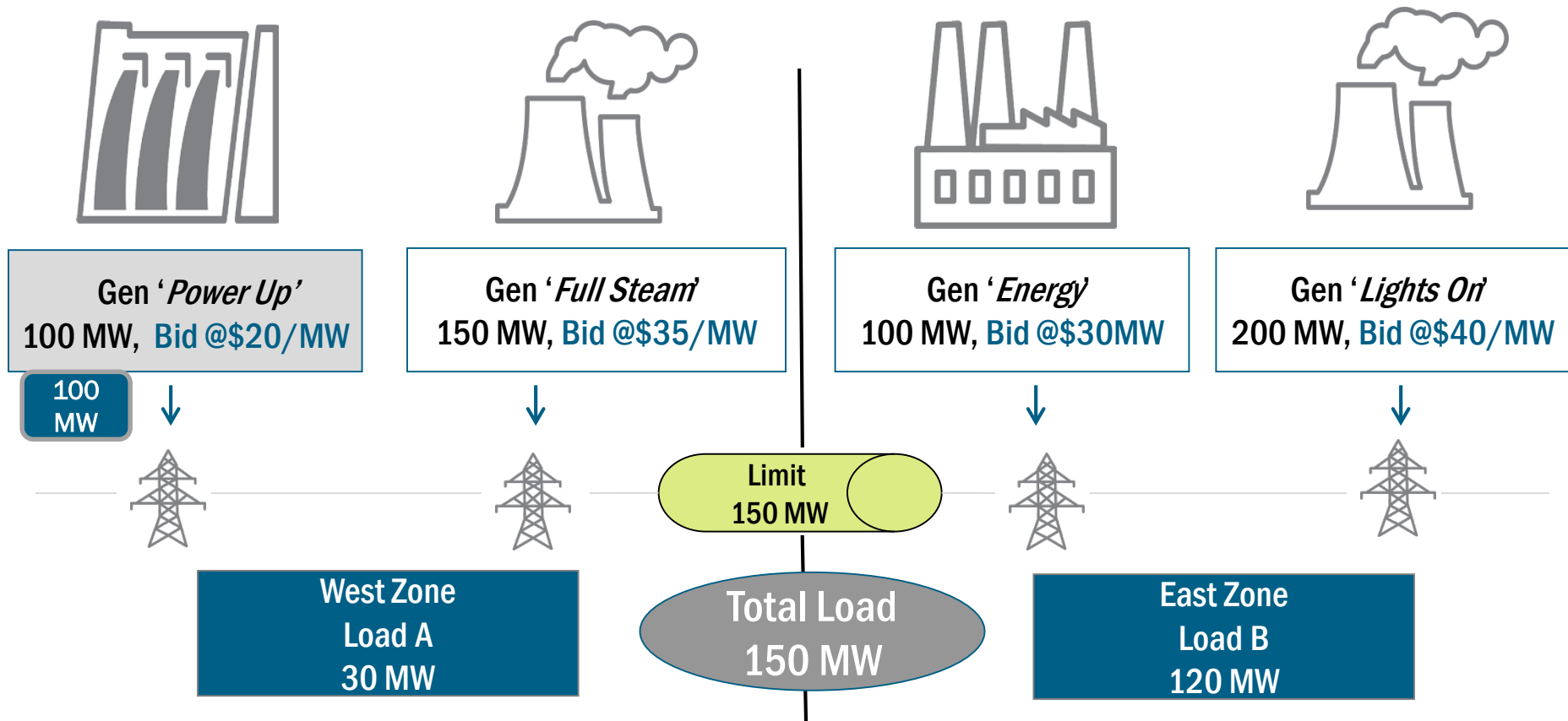


Total Load = 150 MW

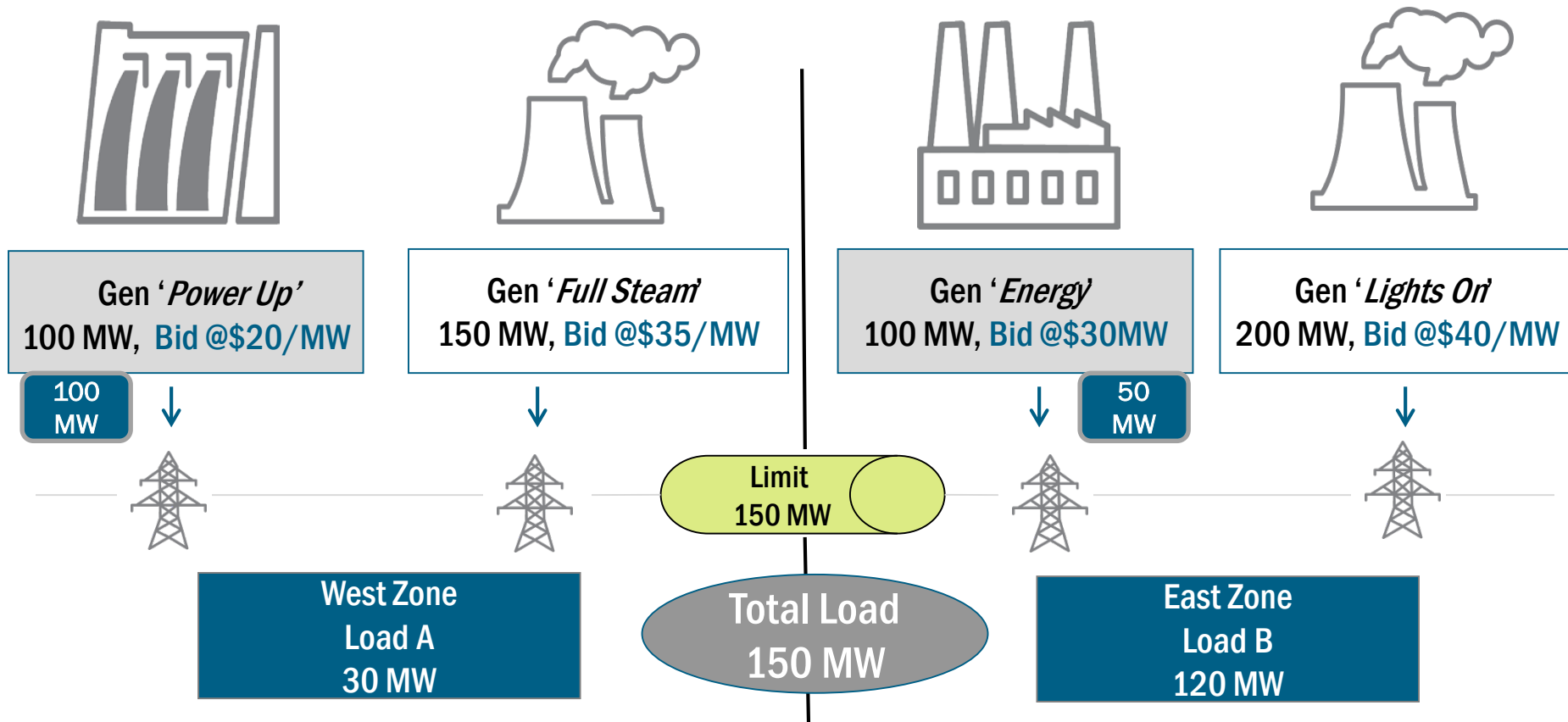
Example 1: Energy Only



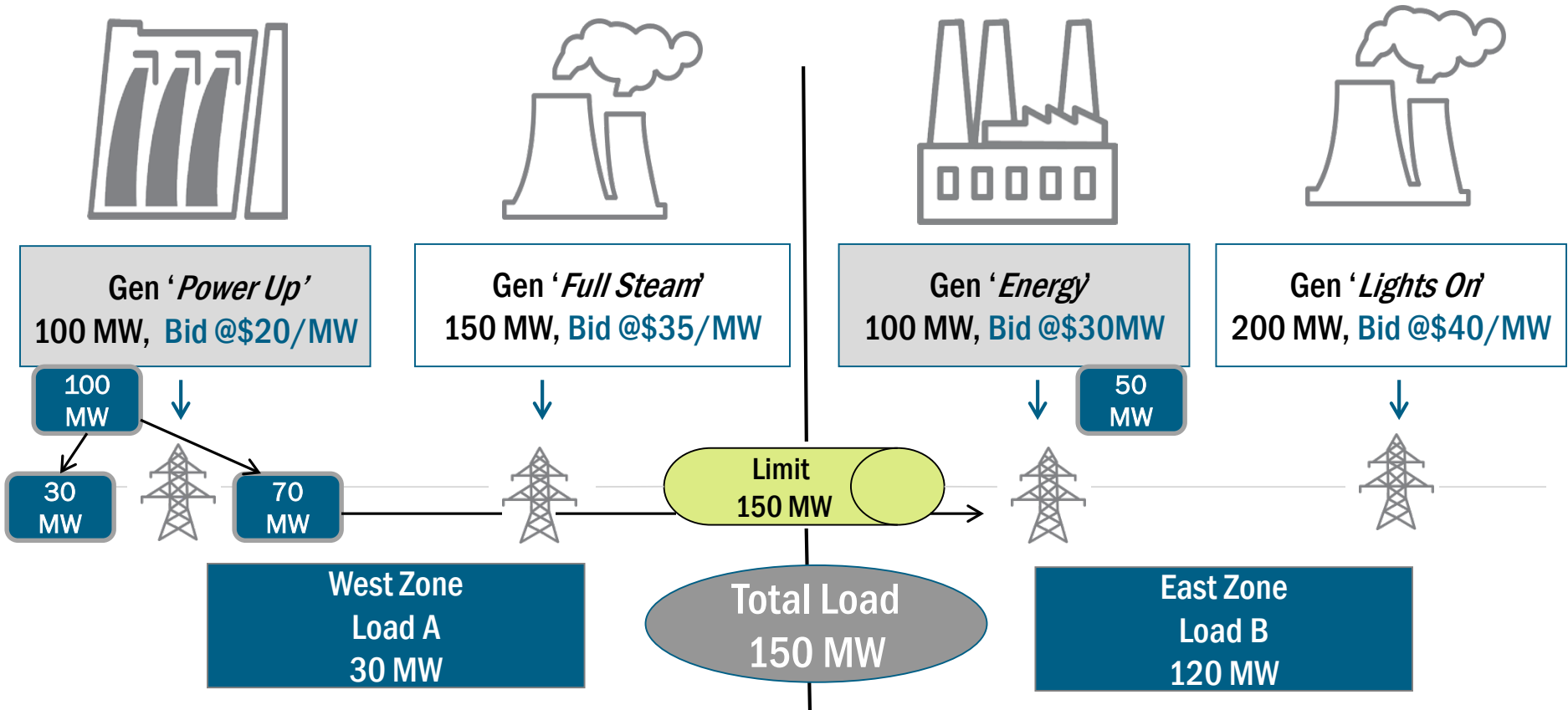
Example 1: Energy Only



Example 1: Energy Only



Example 1: Energy Only



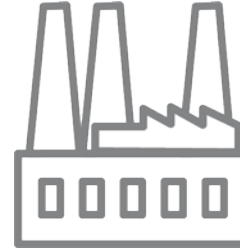
Example 1: Energy Only - Results



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

Energy \$30.00
Loss \$0.00
Congestion -\$0.00
LBMP \$30.00

West Zone
Load A
30 MW

West Zone LBMP \$30.00



Limit
150 MW

Total Load
150 MW



East Zone
Load B
120 MW

East Zone LBMP \$30.00

Energy \$30.00
Loss \$0.00
Congestion -\$0.00
LBMP \$30.00

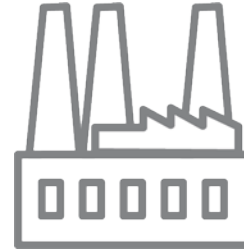
Example 1: Energy Only - Results



Gen '*Power Up*', 100 MW
Bid \$20, Paid \$30



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

West Zone

East Zone

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

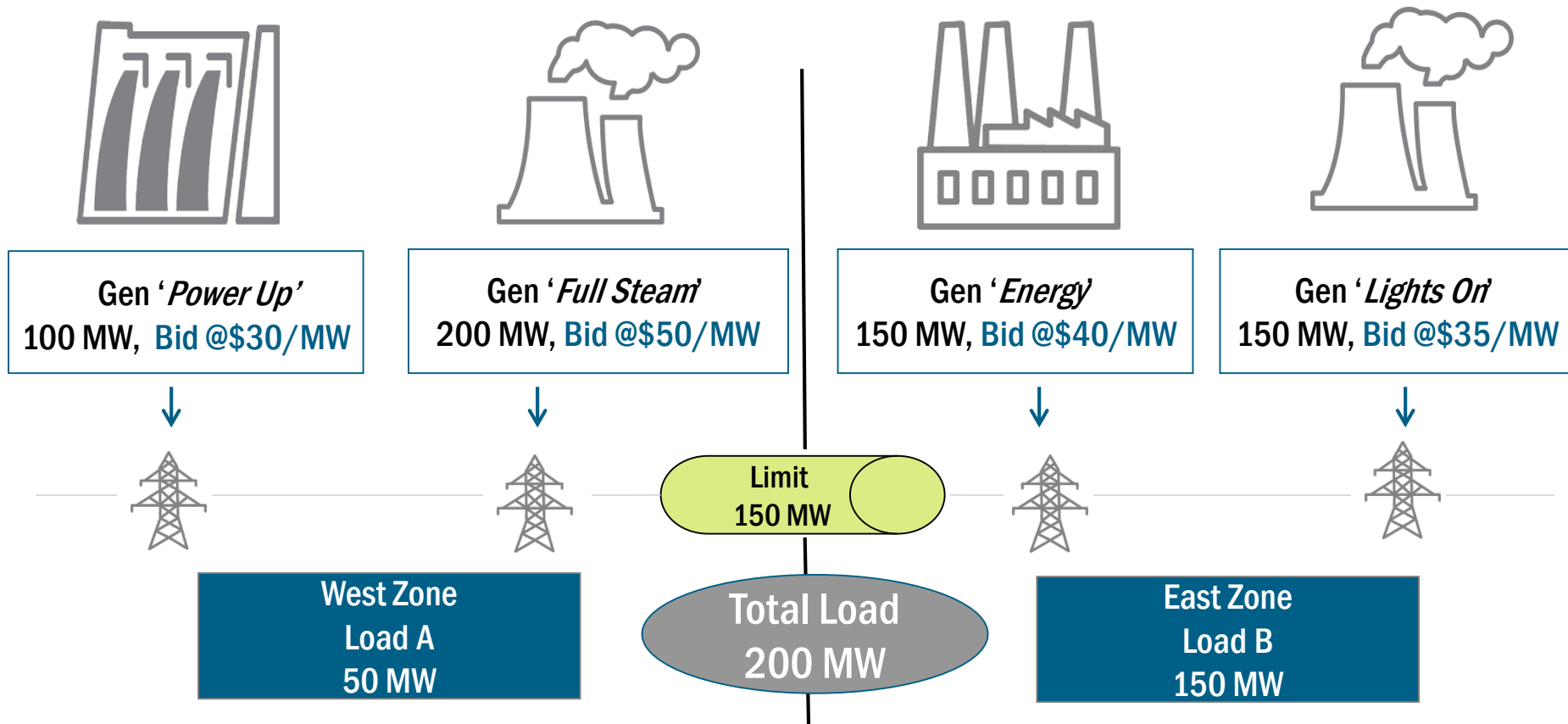
Example 2: Energy Only

No Losses and No Congestion

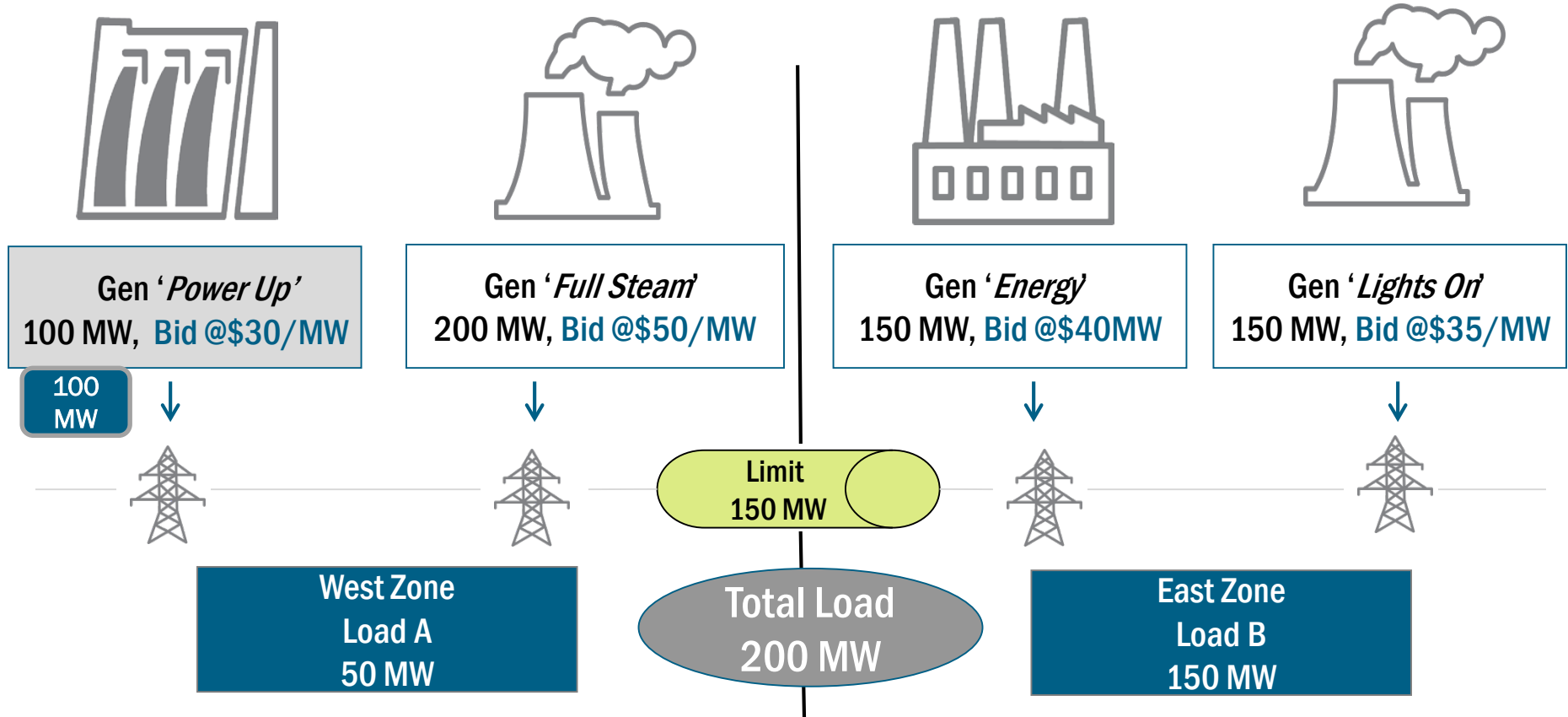


Total Load = 200 MW

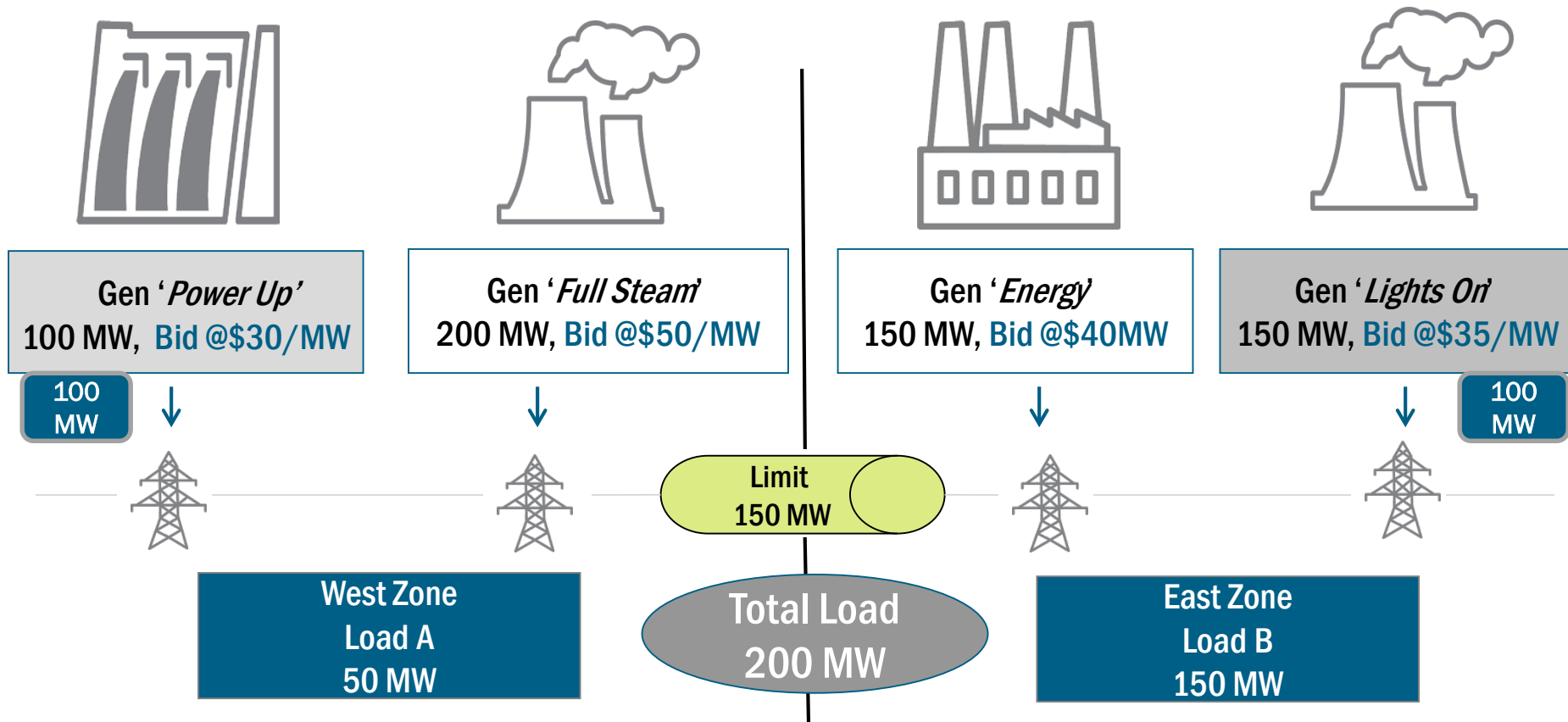
Example 2: Energy Only



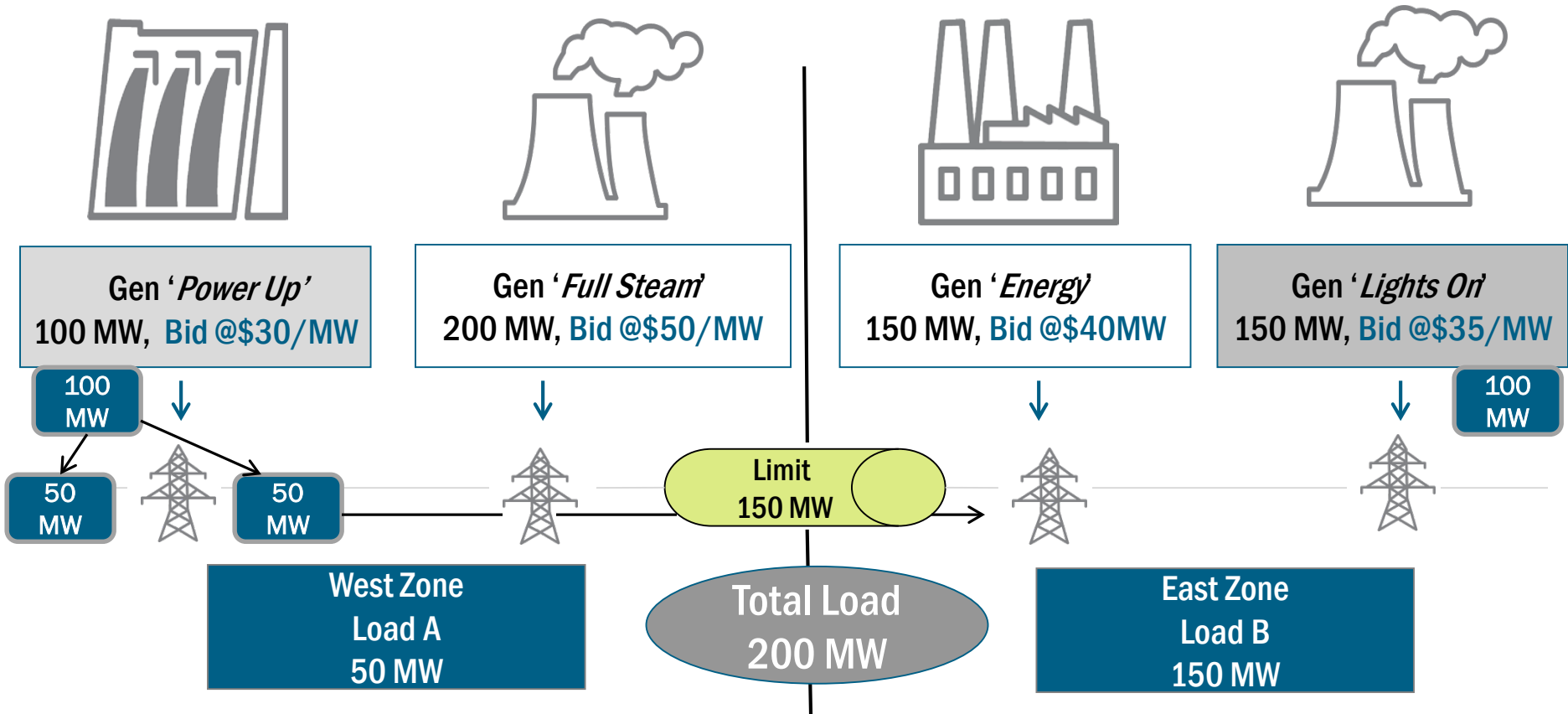
Example 2: Energy Only



Example 2: Energy Only



Example 2: Energy Only



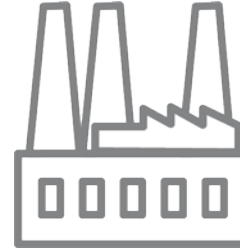
Example 2: Energy Only - Results



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

Energy \$35.00
Loss \$0.00
Congestion -\$0.00
LBMP \$35.00

West Zone
Load A
50 MW

West Zone LBMP \$35.00



Limit
150 MW

Total Load
200 MW



East Zone
Load B
150 MW

East Zone LBMP \$35.00

Energy \$35.00
Loss \$0.00
Congestion -\$0.00
LBMP \$35.00

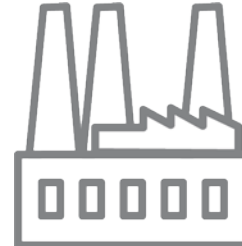
Example 2: Energy Only - Results



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

West Zone

East Zone

Generators receive \$35/MW (LBMP)

Example 2: Energy Only - Results

Loads Charged \$35/MW (LBMP)



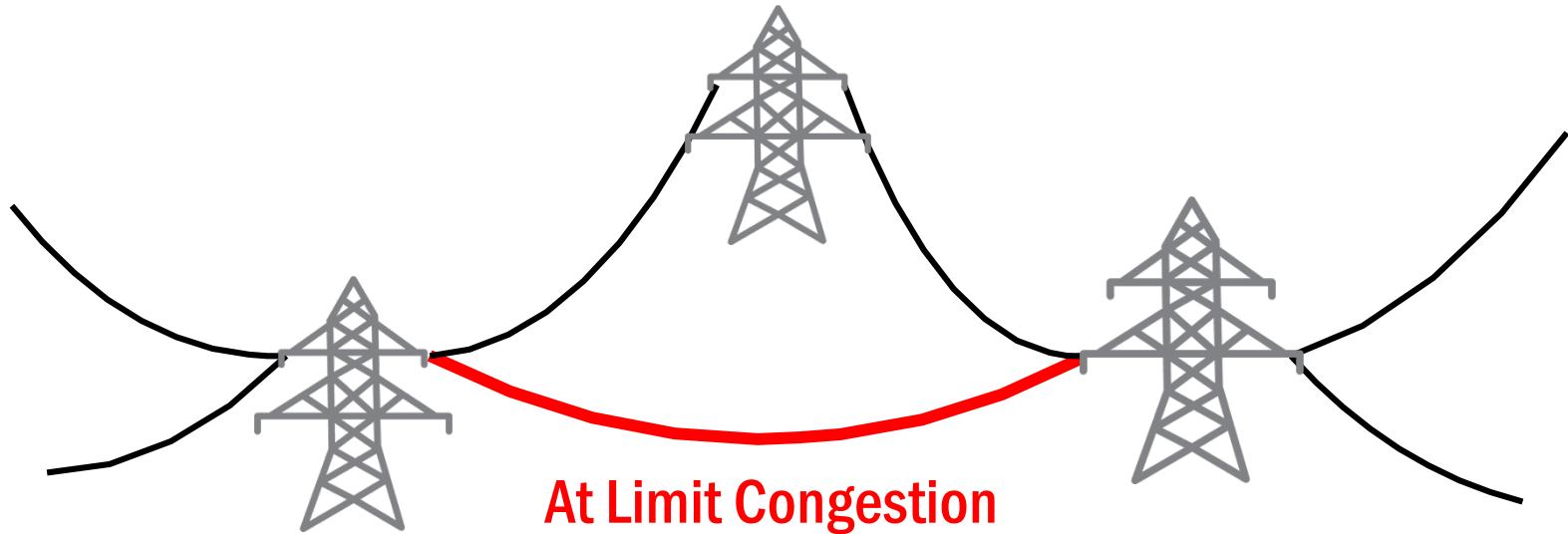
West Zone
Load A
50 MW



East Zone
Load B
150 MW

Congestion

Congestion occurs when the Power flow reaches the Transmission Limit



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

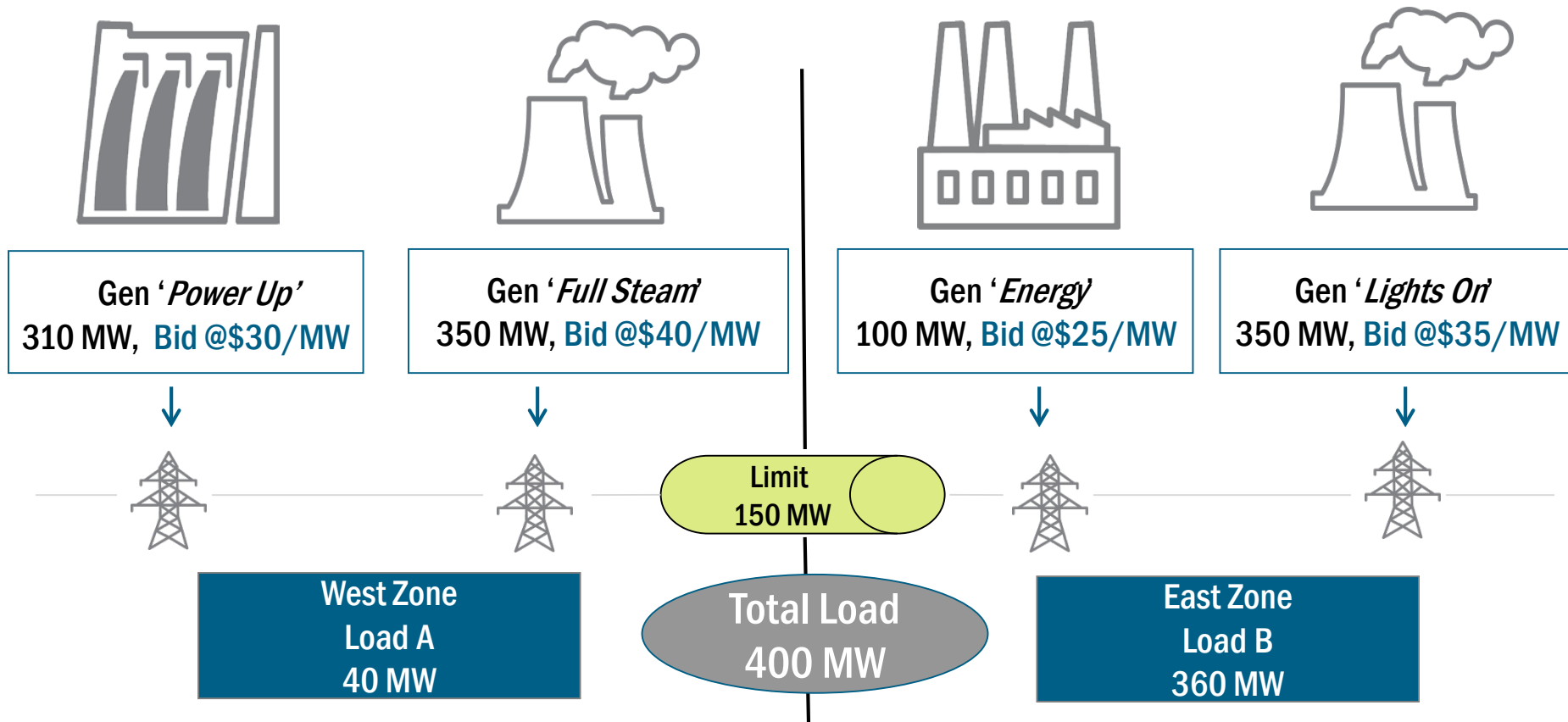
- Generator Derates
- Line Outages
- Transaction Curtailments
- TSA – Severe Weather Conditions
- Reserve Shortage
- Alert State
- OOM & SRE Request
- Forecast Load vs. Actual RT Load

Example 3: Energy and Congestion, No Losses

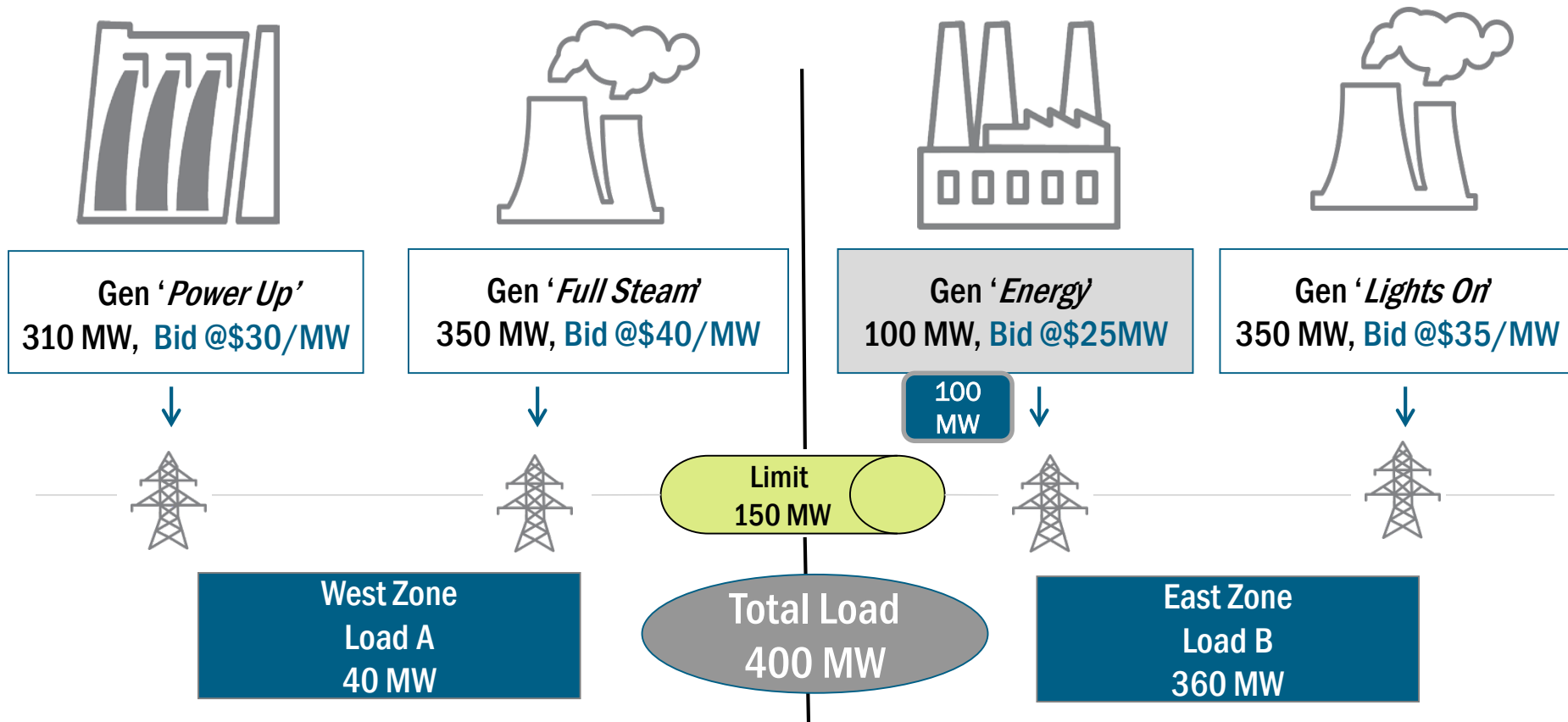


Total Load = 400 MW

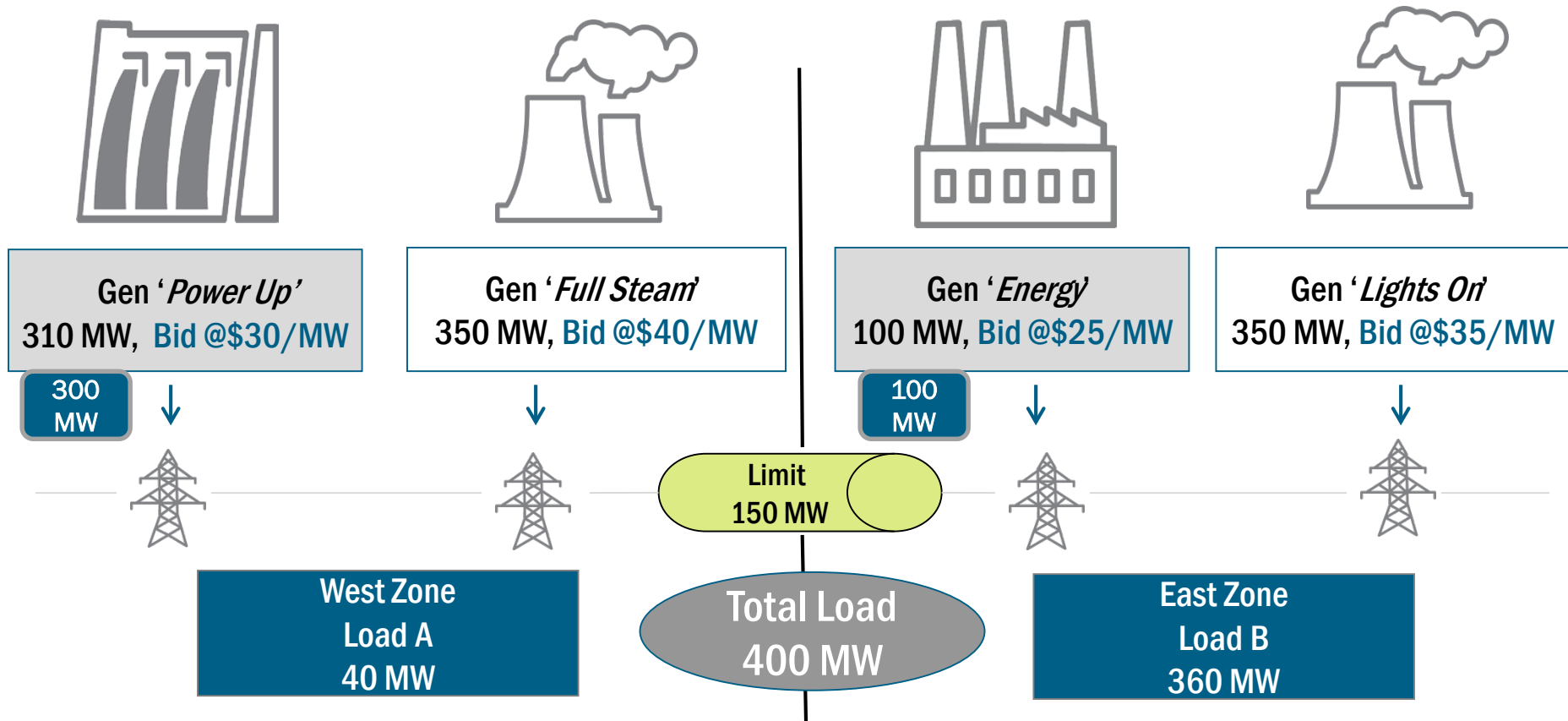
Example 3: Energy and Congestion



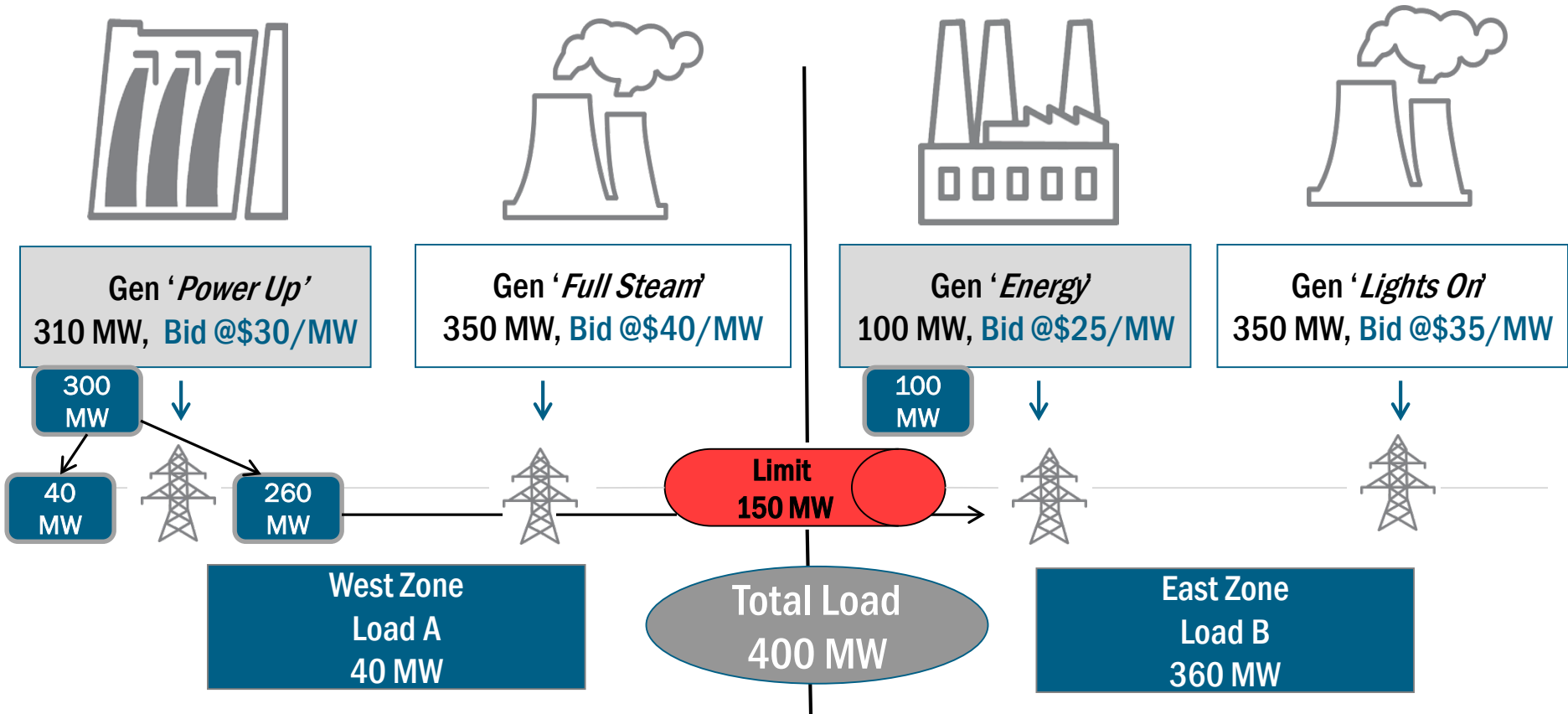
Example 3: Energy and Congestion



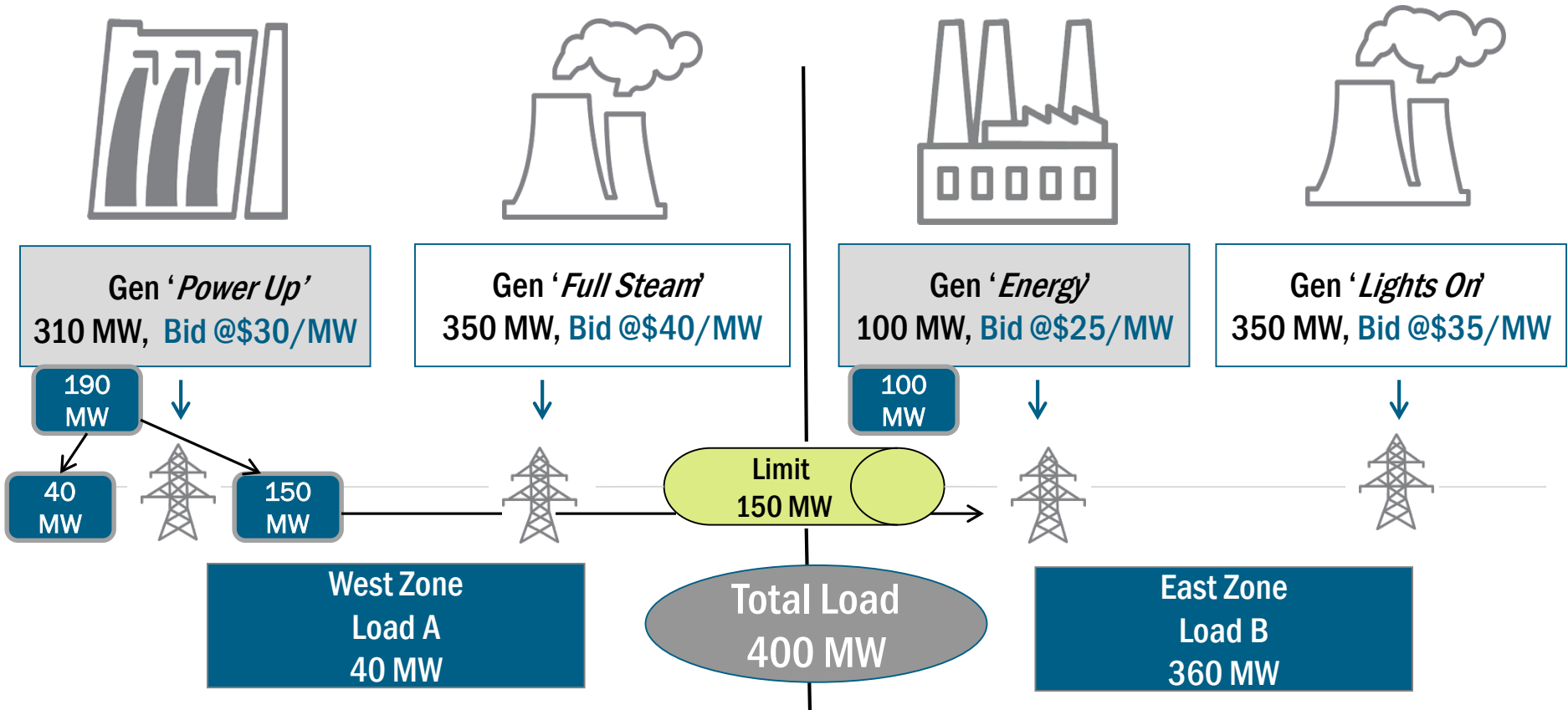
Example 3: Energy and Congestion



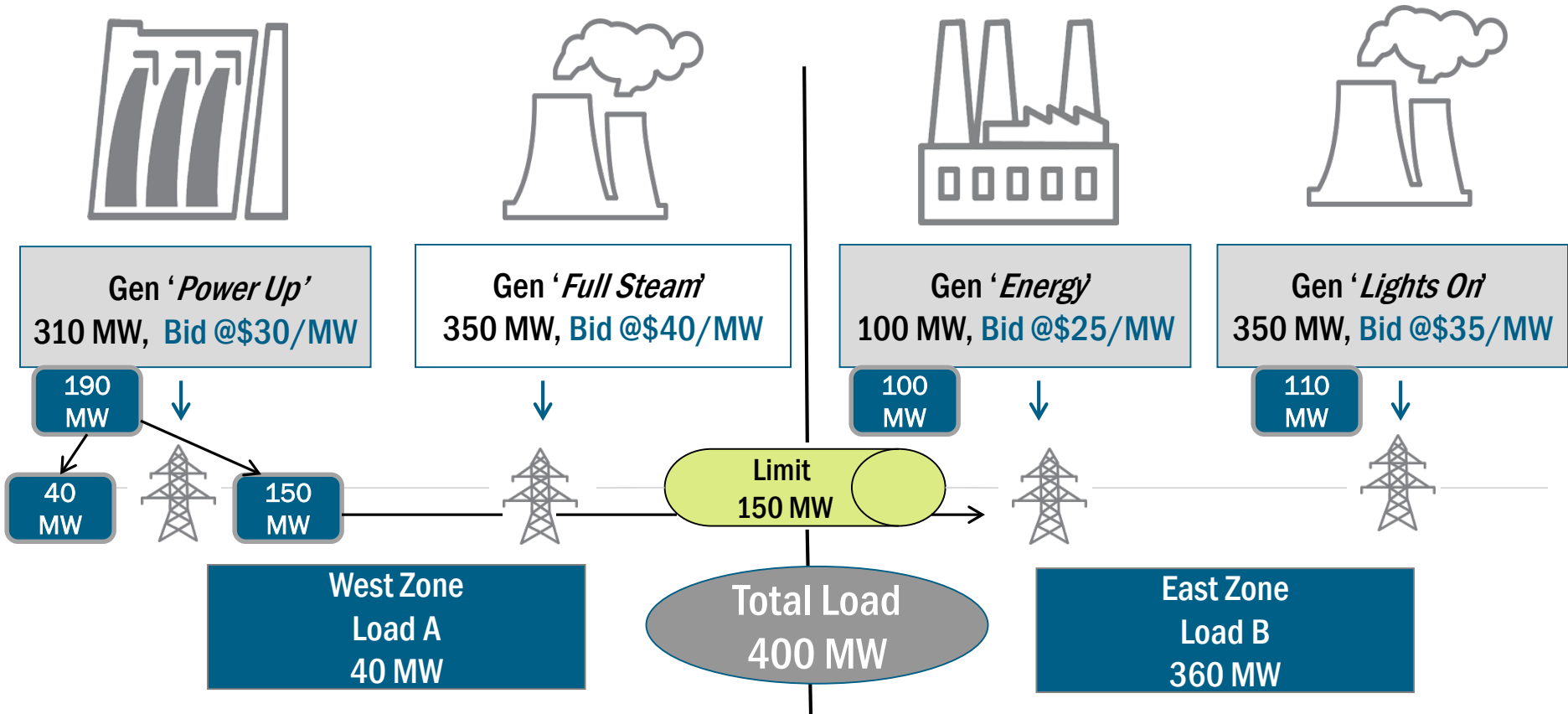
Example 3: Energy and Congestion



Example 3: Energy and Congestion



Example 3: Energy and Congestion



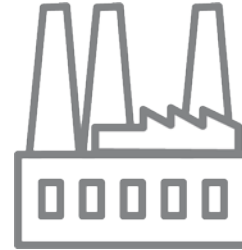
Example 3: Energy and Congestion - Results



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

Energy \$30.00
Loss \$0.00
Congestion -\$0.00
LBMP \$30.00

West Zone
Load A
40 MW

West Zone LBMP \$30.00



Limit
150 MW

Total Load
400 MW



East Zone
Load B
360 MW

East Zone LBMP \$35.00

Energy \$30.00
Loss \$0.00
Congestion -\$5.00
LBMP \$35.00

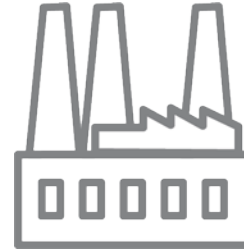
Example 3: Energy and Congestion -Results



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 ?

West Zone

East Zone

Generator "Power Up " receives \$30/MW (LBMP)

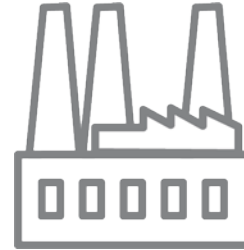
Example 3: Energy and Congestion -Results



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 \$35



Gen '*Lights Ori*', 350 MW
Bid \$35, Paid \$35

West Zone

East Zone

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

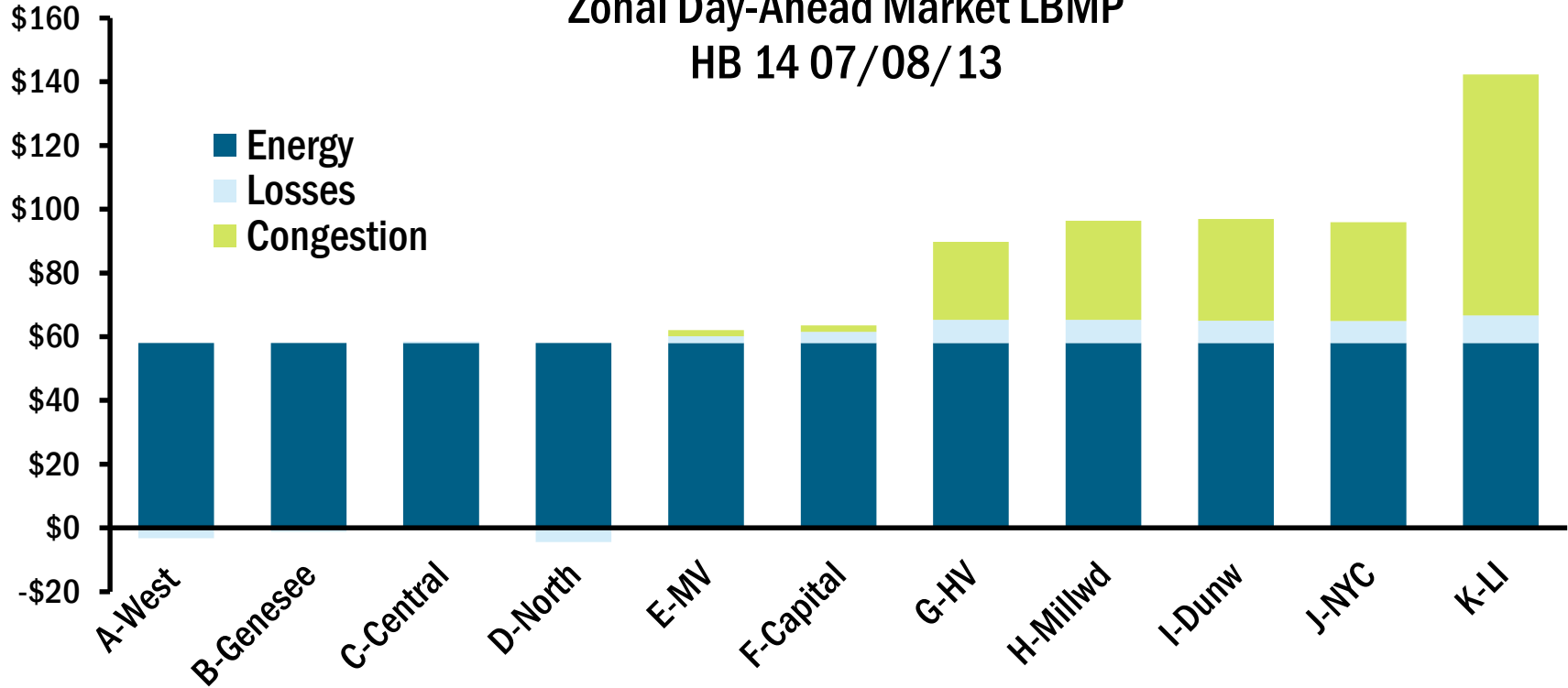
Loads in East Zone
Charged \$35/MW (LBMP)



East Zone
Load B
360 MW

Day Ahead LBMP- Zonal pattern for 1 hour

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

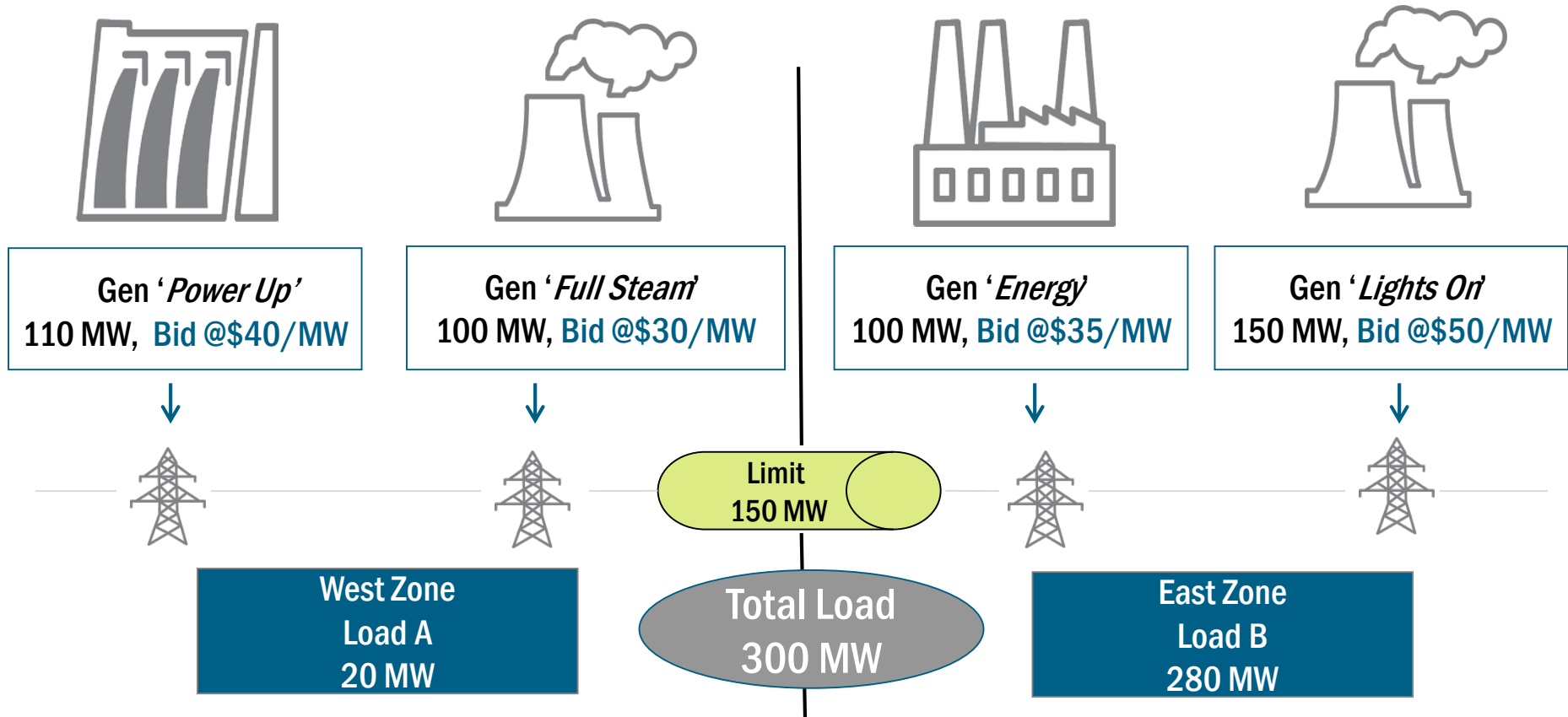


Example 4: Energy and Congestion, No Losses

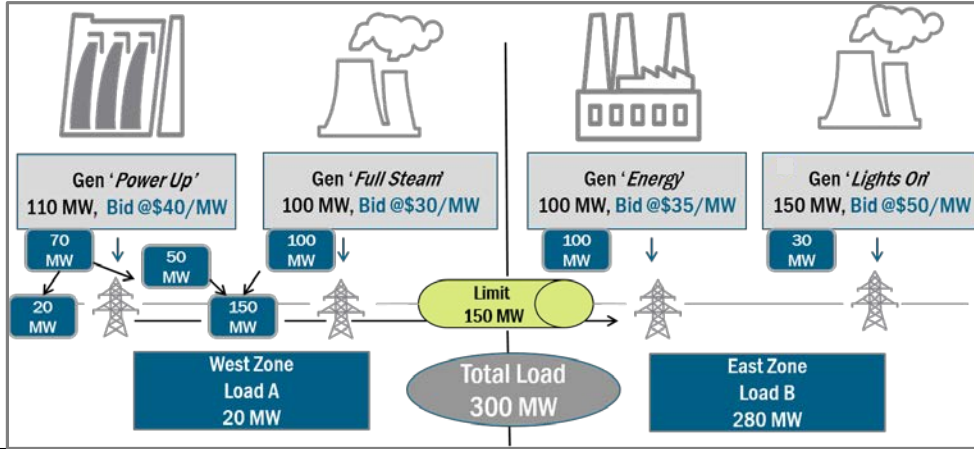


Total Load = 300 MW

Example 4: Energy and Congestion



Example 4: Energy and Congestion – Results



Loads Charged \$?
Generators Paid \$?

\$? Difference =
Congestion Rent

| | | | | | |
|------------------------------------|------|-------|------------|-----|---------------|
| 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 \$? | \$? | \$? |

LBMP Components on the NYISO website



Day Ahead Market Zonal LBMP

| | | --- LBMP \$ | | | | | | | | | | | | | | | | | | | --- Marginal Cost of Losses | | | | | --- Marginal Cost of Congestion | | | | | 12/05/2017 |
|------------|-------|-------------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----------------------------|-------|-------|-------|--------|---------------------------------|--|--|--|--|------------|
| Zonal Data | | 00:00 | 01:00 | 02:00 | 03:00 | 04:00 | 05:00 | 06:00 | 07:00 | 08:00 | 09:00 | 10:00 | 11:00 | 12:00 | 13:00 | 14:00 | 15:00 | 16:00 | 17:00 | 18:00 | 19:00 | 20:00 | 21:00 | 22:00 | 23:00 | | | | | | |
| Name | PTID | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | EST | | | | | | |
| CAPITL | 61757 | 29.72 | 25.19 | 25.98 | 23.15 | 24.45 | 22.61 | 27.54 | 28.15 | 27.81 | 31.93 | 31.91 | 27.75 | 28.93 | 28.11 | 28.85 | 28.06 | 34.82 | 38.63 | 34.29 | 32.65 | 31.82 | 26.66 | 25.41 | 24.62 | | | | | | |
| | | 0.28 | 0.27 | 0.27 | 0.27 | 0.27 | 0.37 | 0.83 | 1.38 | 1.73 | 1.69 | 1.63 | 1.68 | 1.67 | 1.65 | 1.51 | 1.65 | 1.97 | 2.71 | 2.35 | 2.23 | 1.97 | 1.58 | 0.99 | 0.40 | | | | | | |
| | | -25.19 | -20.68 | -21.48 | -18.63 | -19.95 | -16.96 | -14.55 | -5.94 | -2.13 | -6.40 | -6.33 | -2.40 | -3.81 | -2.94 | -6.07 | -3.56 | -5.89 | 0.24 | 0.20 | 0.09 | -2.45 | -2.77 | -9.35 | -17.78 | | | | | | |
| CENTRL | 61754 | 6.88 | 6.40 | 6.46 | 6.19 | 6.30 | 7.13 | 13.94 | 21.78 | 24.28 | 24.59 | 24.65 | 23.99 | 23.90 | 23.86 | 22.00 | 23.34 | 27.73 | 36.19 | 32.14 | 30.60 | 27.71 | 22.57 | 16.07 | 8.37 | | | | | | |
| | | 0.03 | 0.02 | 0.01 | 0.03 | 0.01 | 0.10 | 0.27 | 0.39 | 0.34 | 0.31 | 0.26 | 0.29 | 0.26 | 0.24 | 0.23 | 0.28 | 0.30 | 0.40 | 0.29 | 0.22 | 0.17 | 0.07 | 0.11 | 0.09 | | | | | | |
| | | -2.60 | -2.14 | -2.22 | -1.92 | -2.06 | -1.75 | -1.51 | -0.54 | 0.01 | -0.44 | -0.43 | -0.04 | -0.19 | -0.09 | -0.49 | -0.21 | -0.47 | 0.36 | 0.29 | 0.13 | -0.14 | -0.20 | -0.90 | -1.84 | | | | | | |

**CAPITL
61757**

**CENTRL
61754**

**NYISO_LBMP_REFERENCE
24008**

LBMP

27.54

13.94

12.16

Loss

0.83

0.27

0.00

Congestion

-14.55

-1.55

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

LBMP is comprised of?

- a) One Single Price Component
- b) Three Separate Price Components

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 a Generator is?

- a) Established at a Zonal level
- b) Established at the Generator Bus

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Additional Resources

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