

# 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

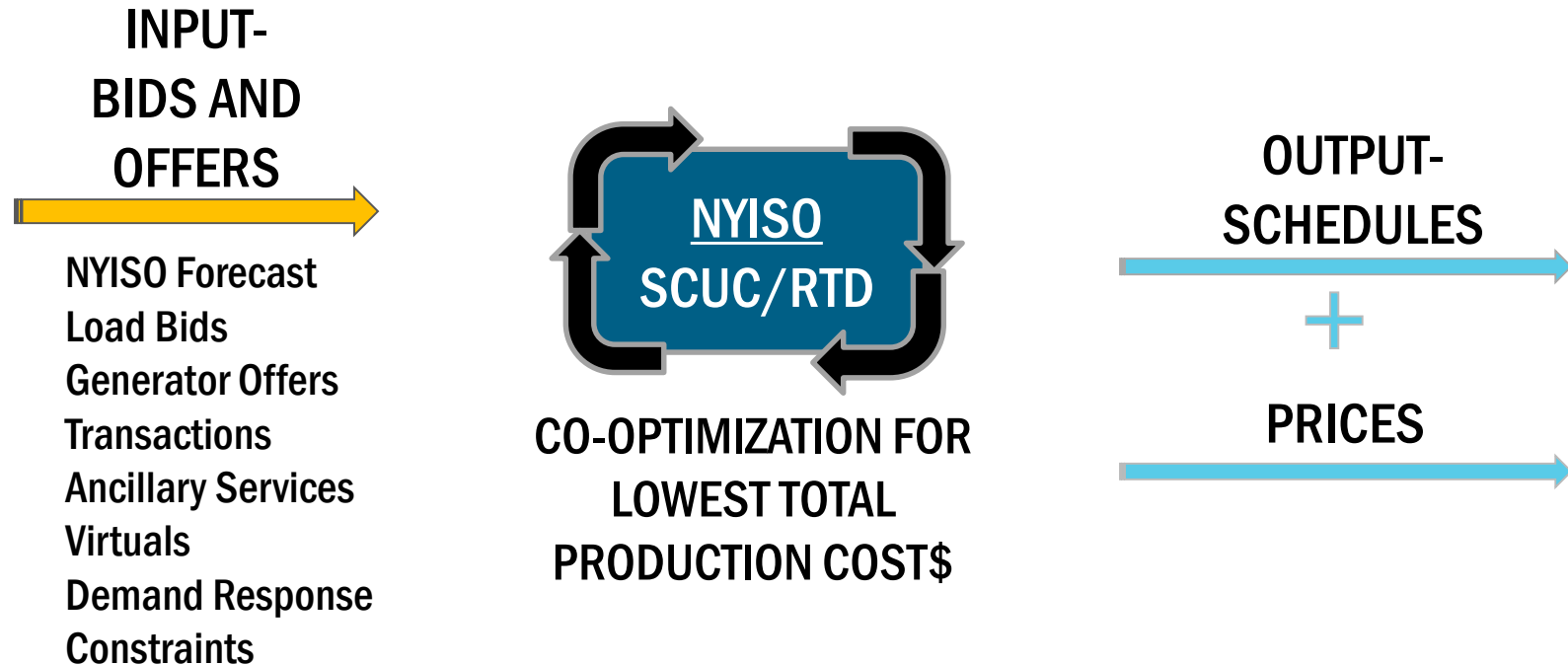
# LBMP - Defined

- 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



# 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

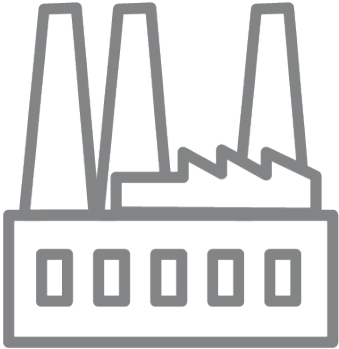
- **Marginal Congestion Price Component**
  - In some instances, dispatching least costly generation may exceed line limitations
  - More costly units may subsequently be dispatched to avoid exceeding those limits

# LBMP Components - Congestion

**Total Load  
100 MW**



# LBMP Components - Congestion



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



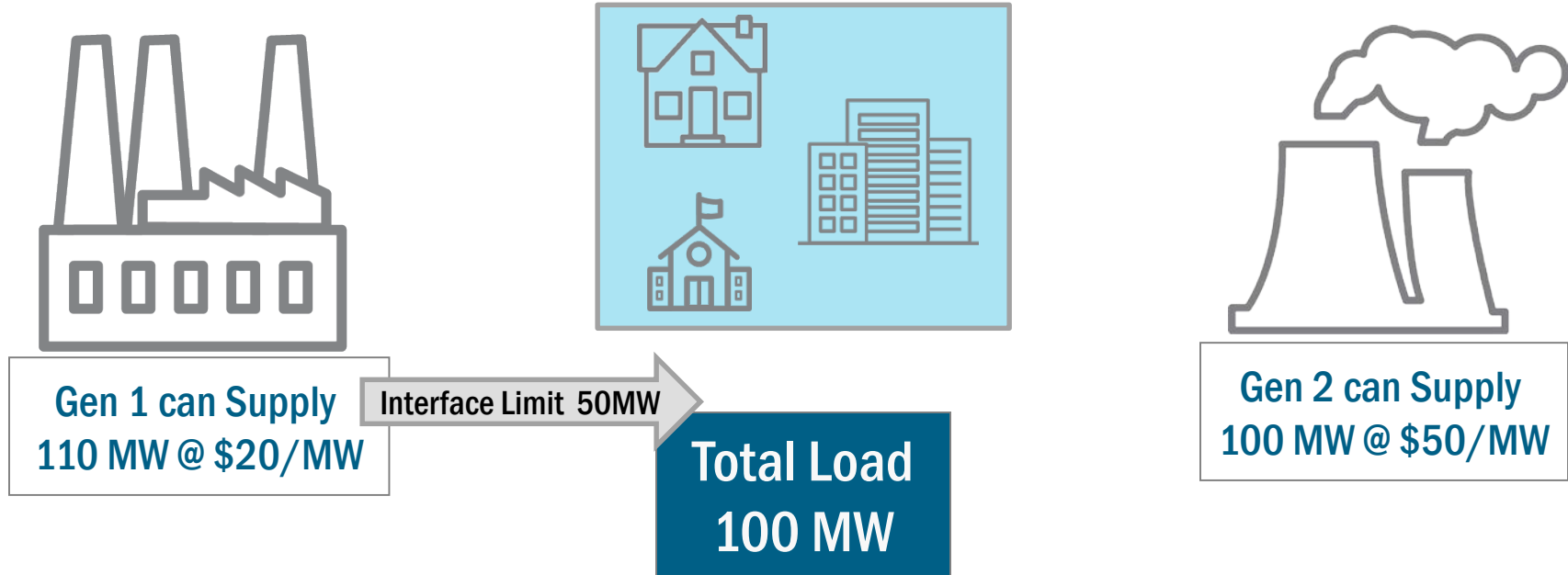
Total Load  
100 MW



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

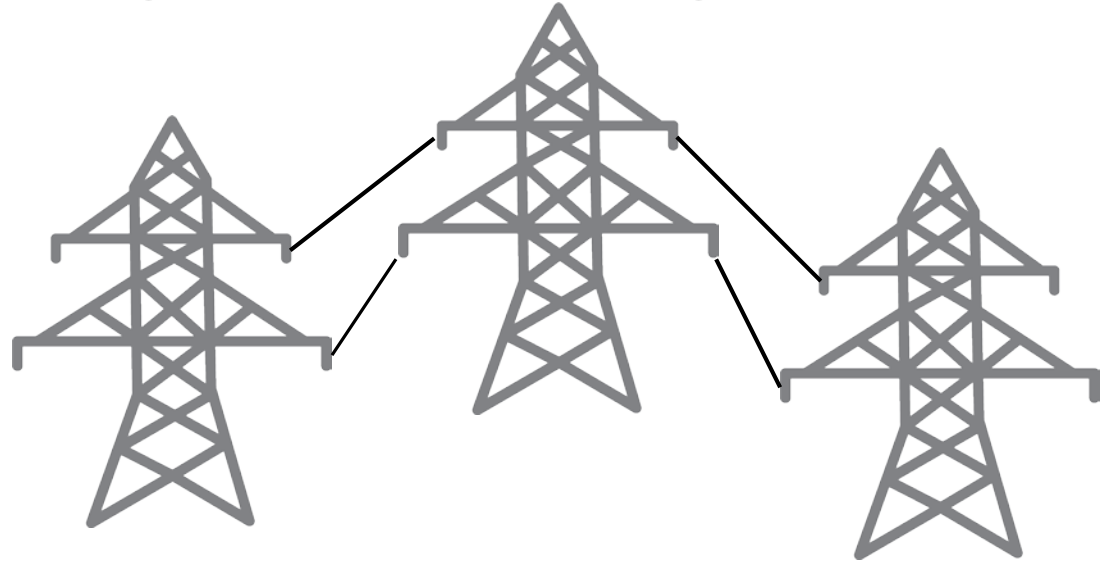


# LBMP Components - Congestion

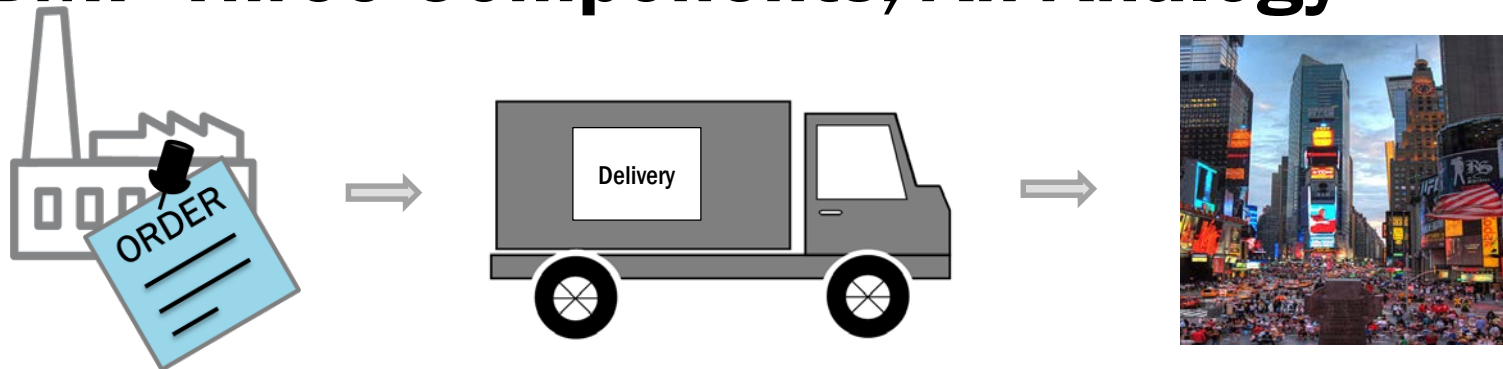


# LBMP Components - Congestion

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



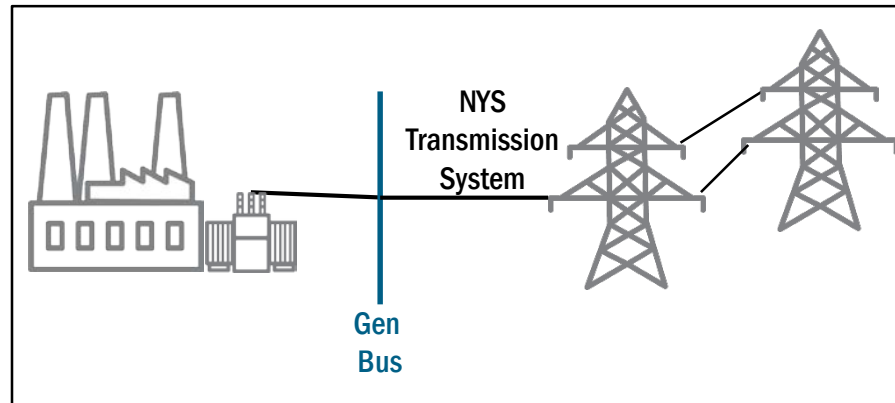
# LBMP-Three Components, An Analogy



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)
<b>Total Cost for Product</b>	<b>\$62</b>	<b>\$86</b>	<b>LBMP</b>

# Generators – Gen Bus LBMP

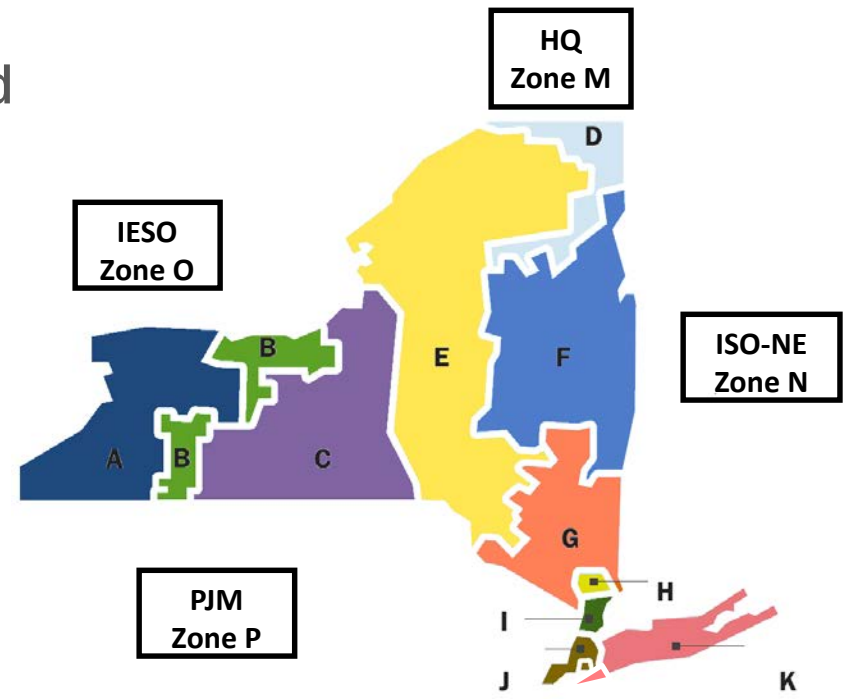
- LBMP for Generators
  - Based on Generator Bus
  - LBMP calculated at Bus where Generator injects power



# 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	



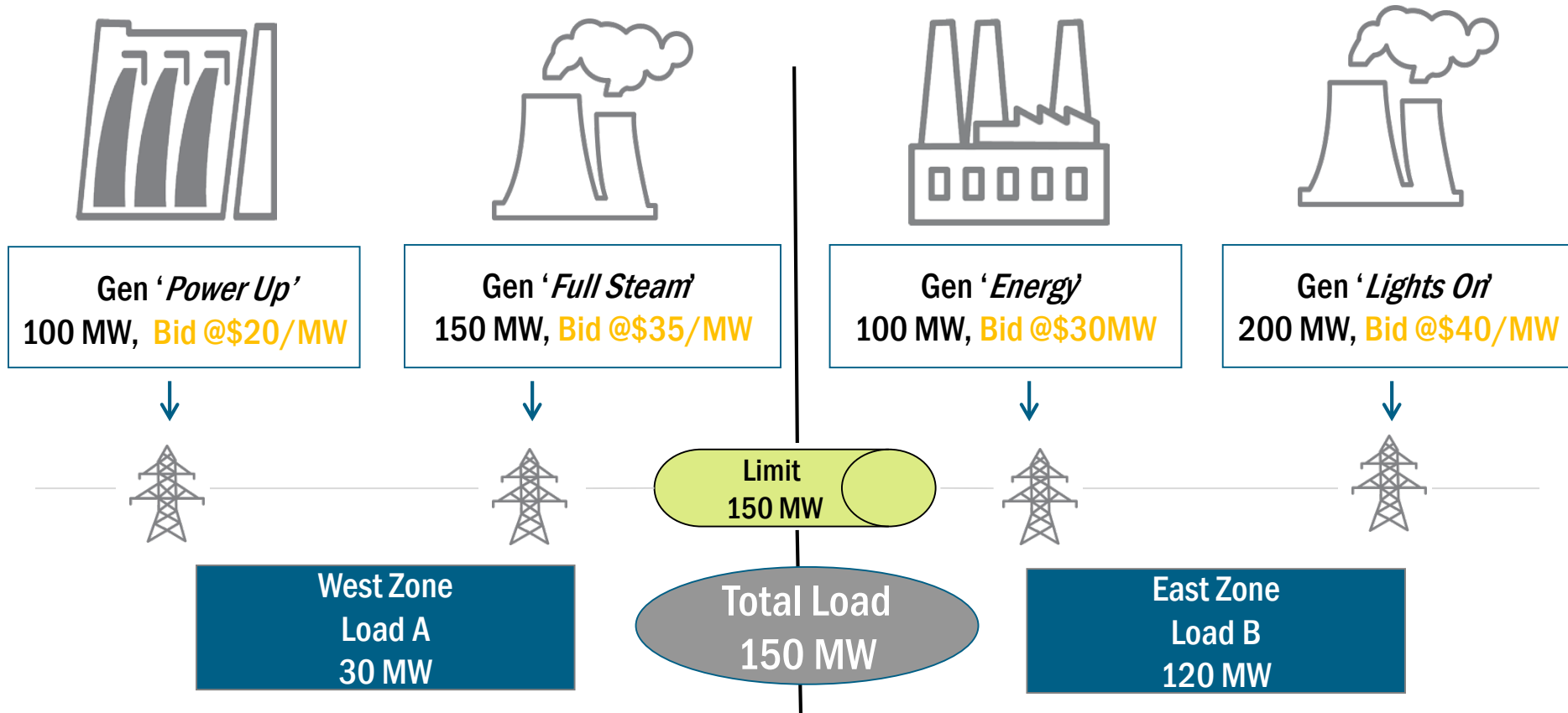
# Example 1: Energy Only

## No Losses and No Congestion

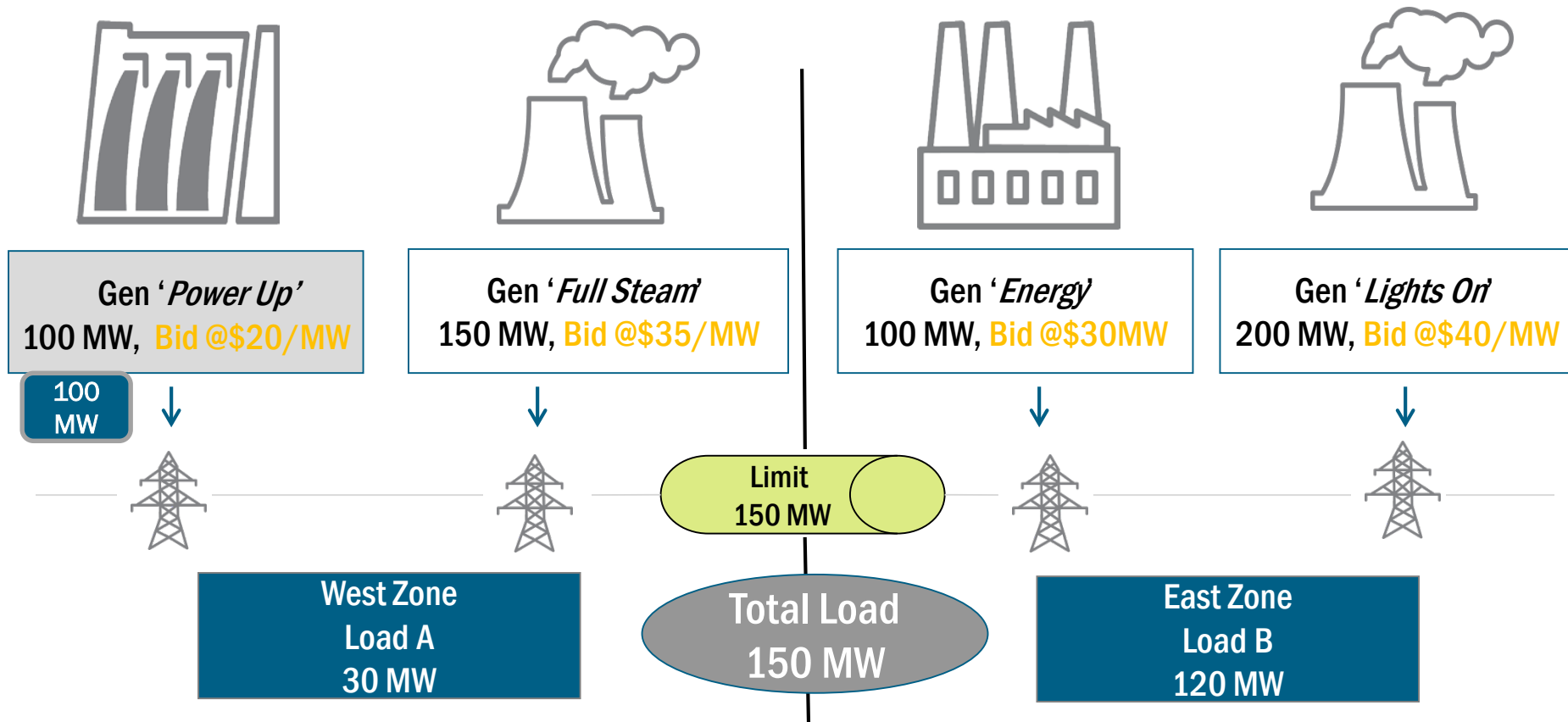


**Total Load = 150 MW**

# Example 1: Energy Only

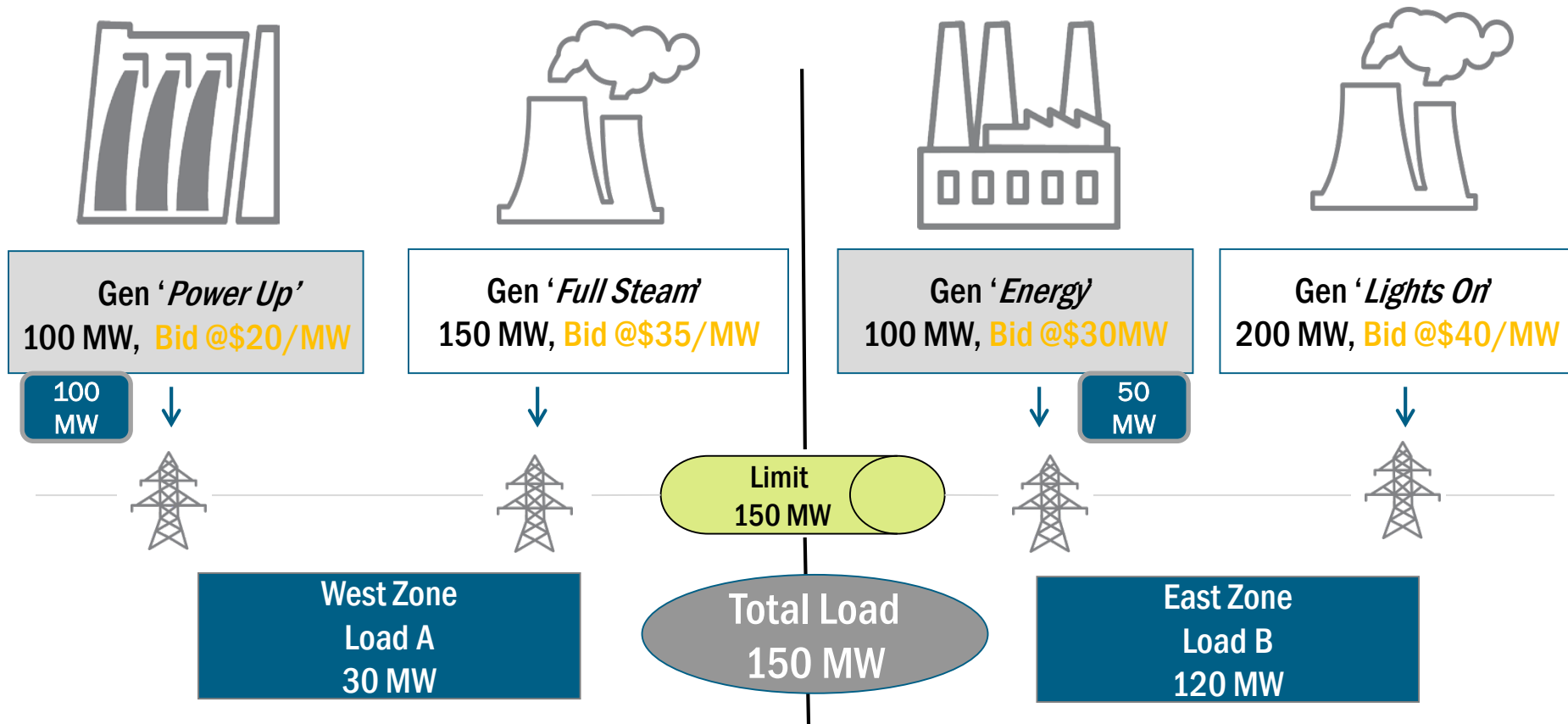


# Example 1: Energy Only

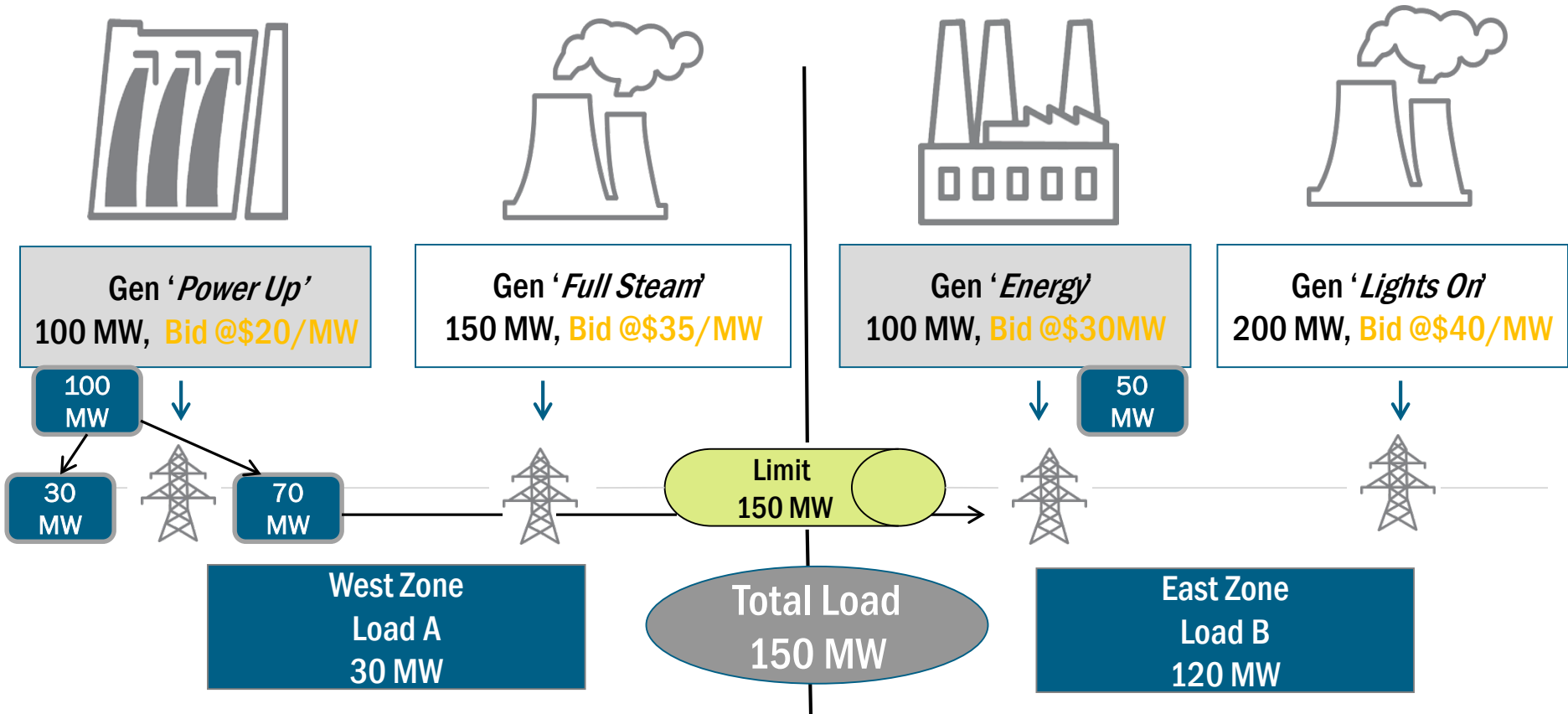




# Example 1: Energy Only



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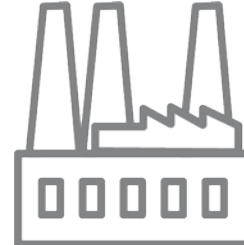
# Example 1: Energy Only - Results



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 \$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

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

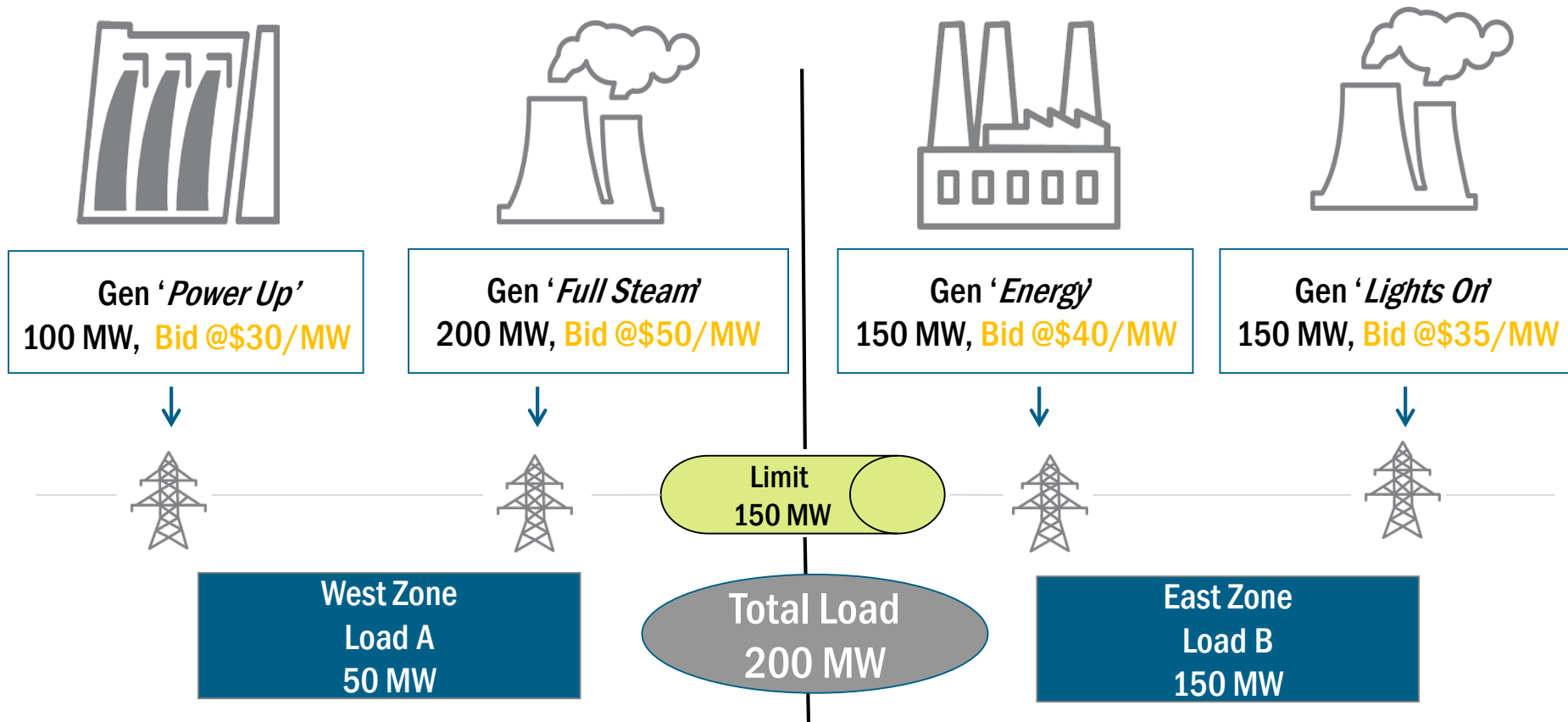
# Example 2: Energy Only

## No Losses and No Congestion

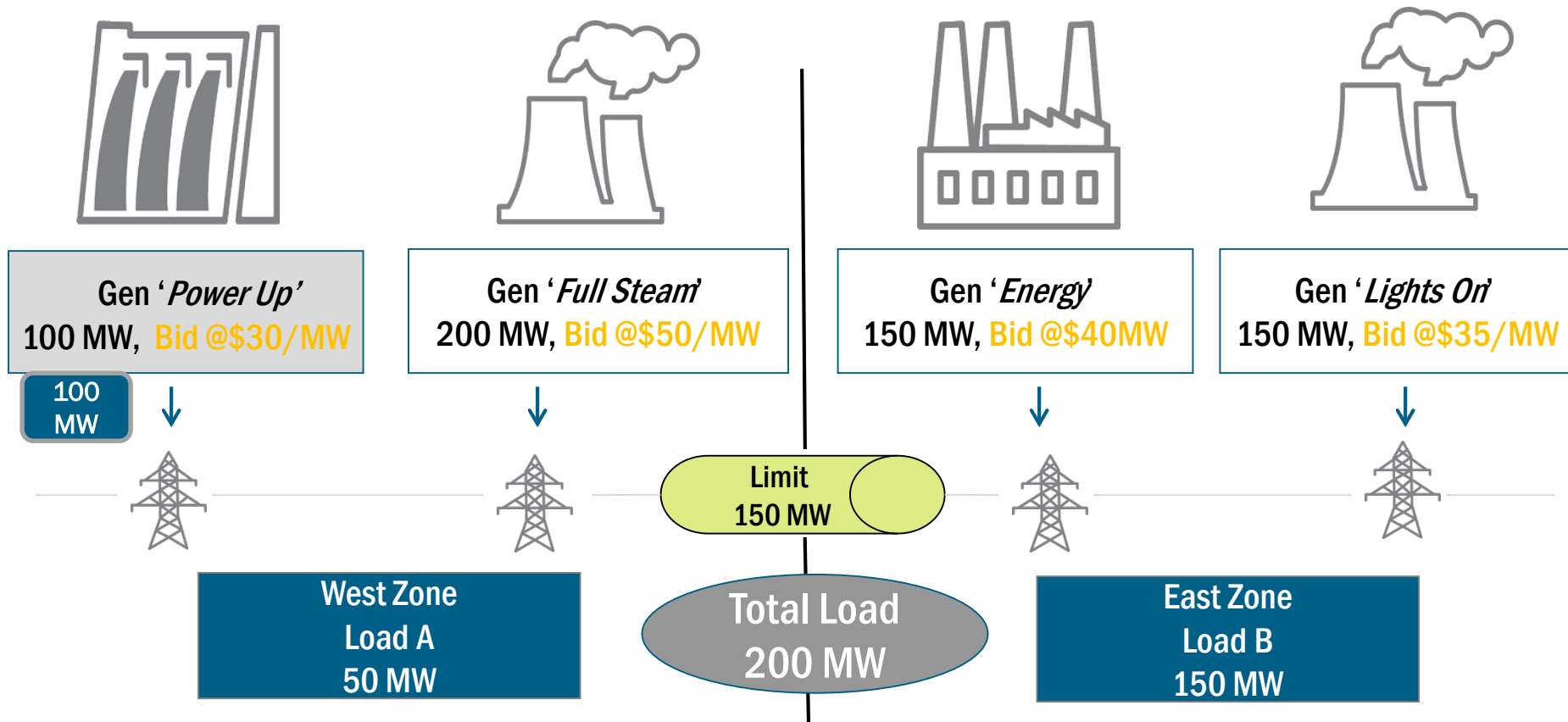


**Total Load = 200 MW**

# Example 2: Energy Only

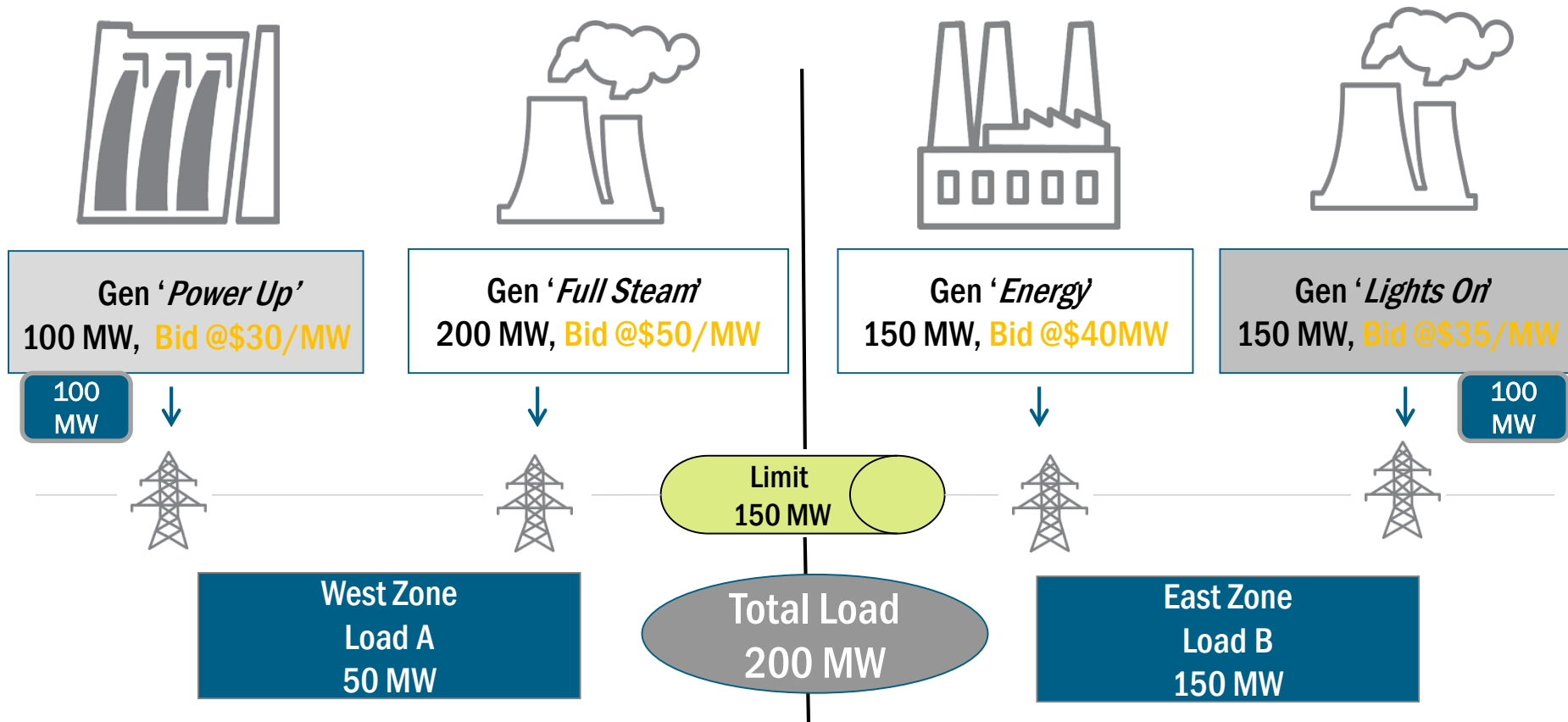


# Example 2: Energy Only

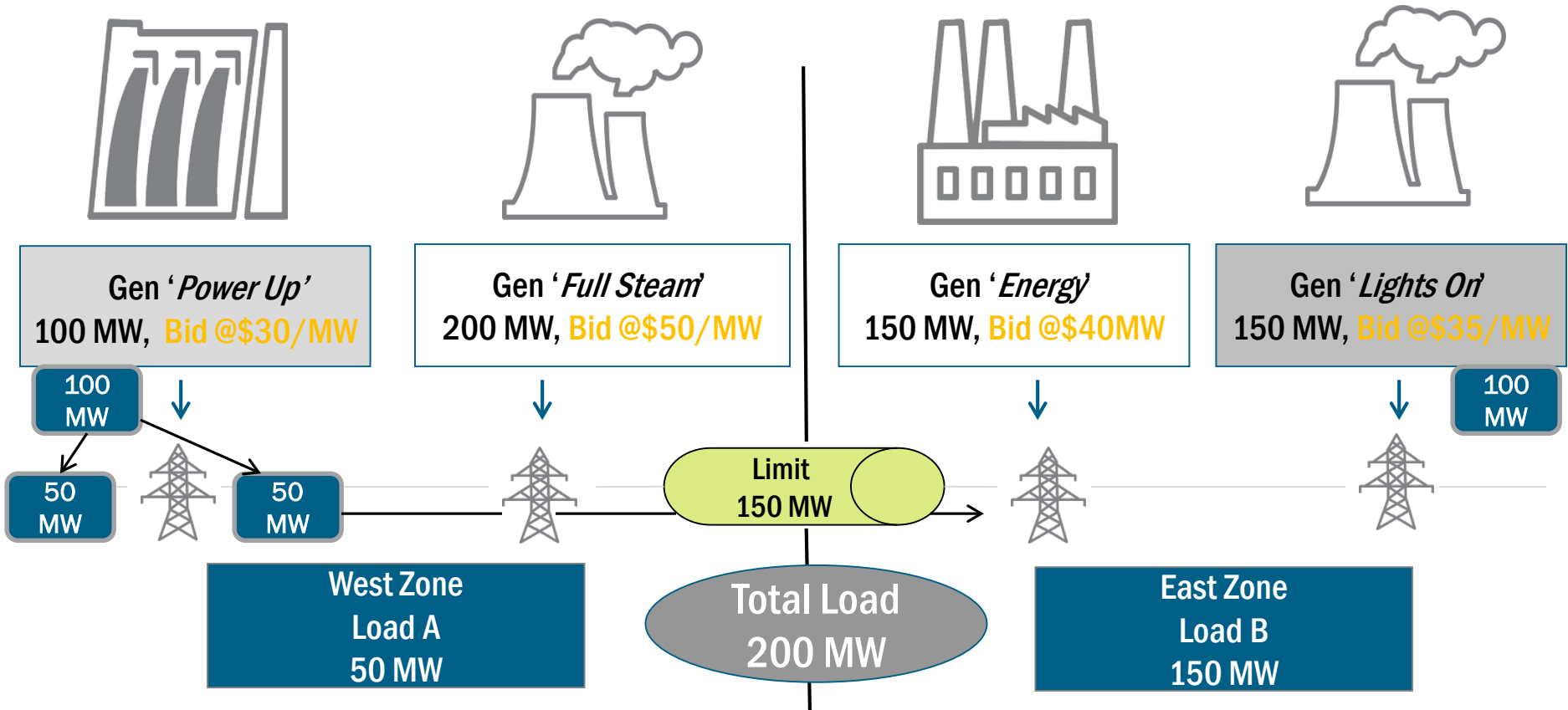




# Example 2: Energy Only



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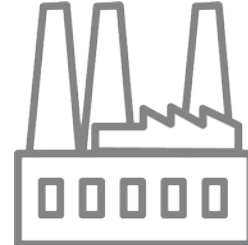
# Example 2: Energy Only - Results



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



Limit  
150 MW



Total Load  
200 MW

West Zone  
Load A  
50 MW

East Zone  
Load B  
150 MW

West Zone LBMP \$35.00

East Zone LBMP \$35.00

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

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

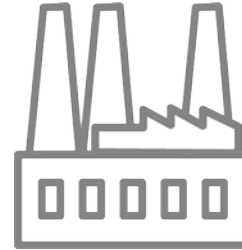
# Example 2: Energy Only - Results



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)



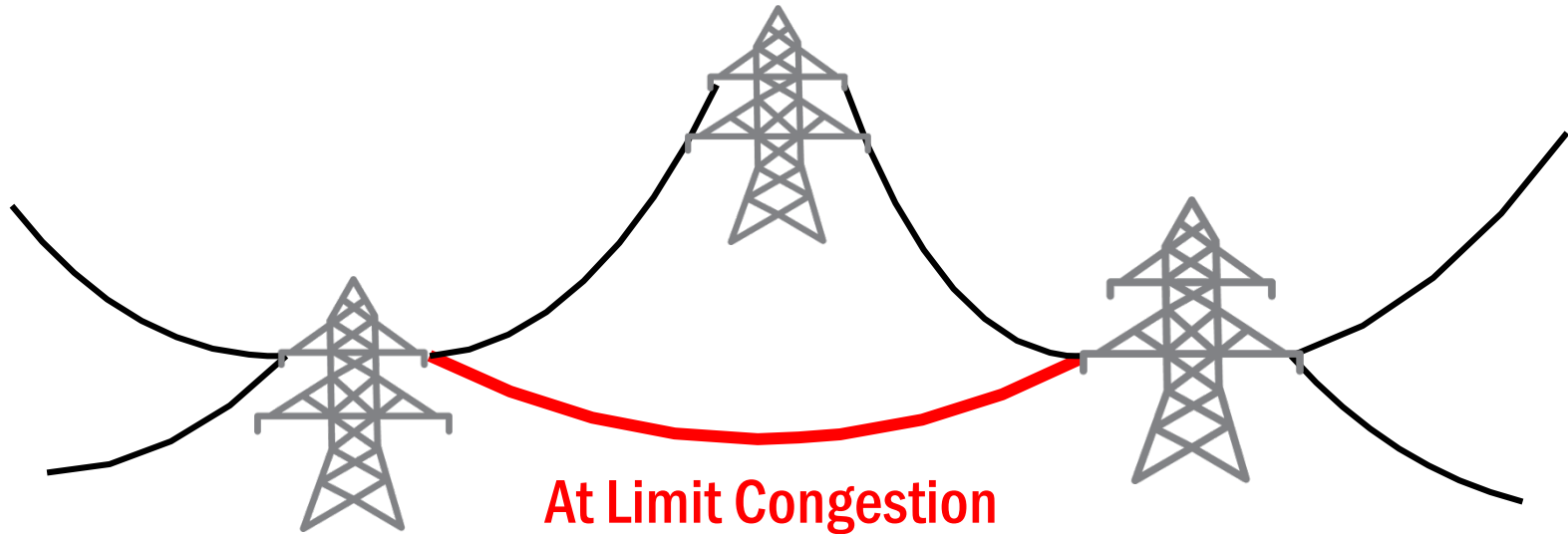
West Zone  
Load A  
50 MW



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

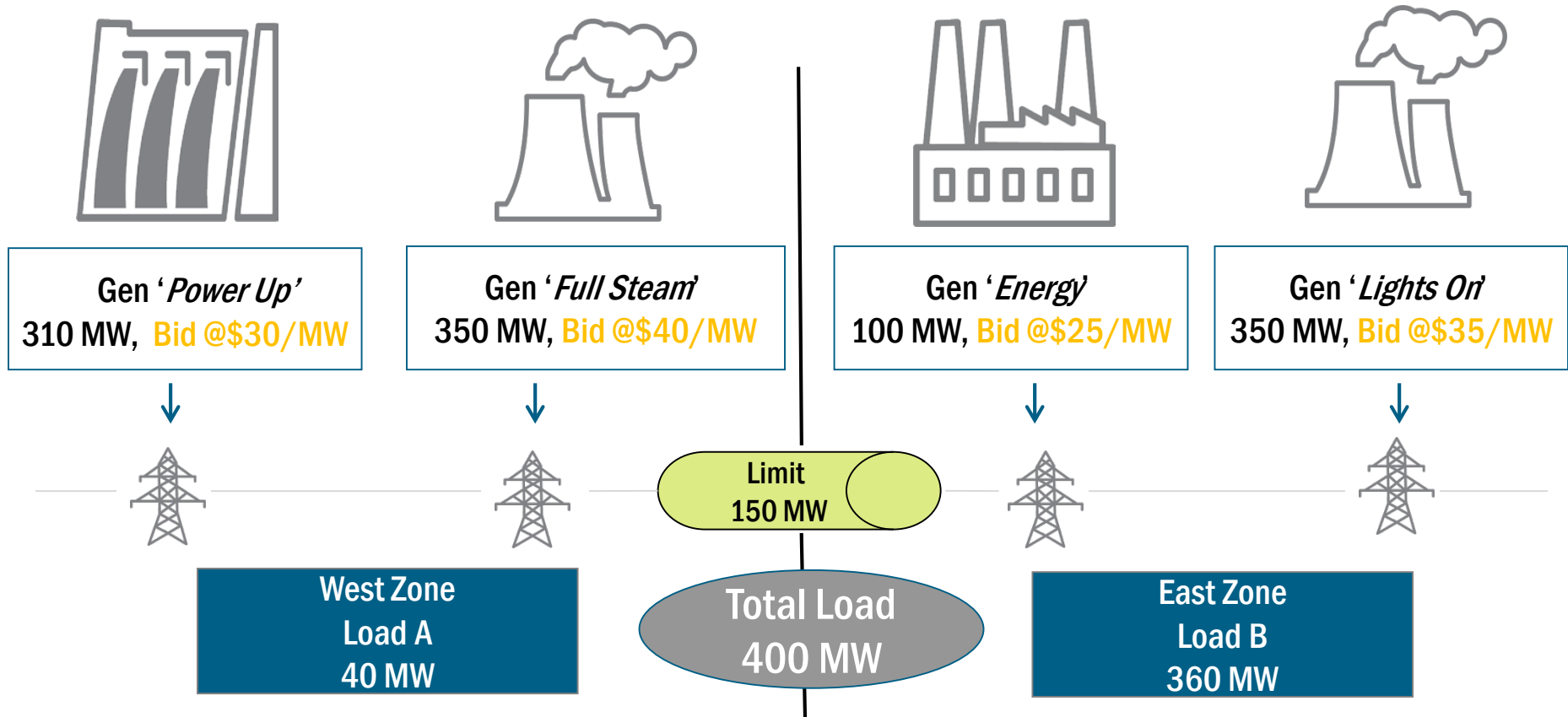


# Example 3: Energy and Congestion, No Losses

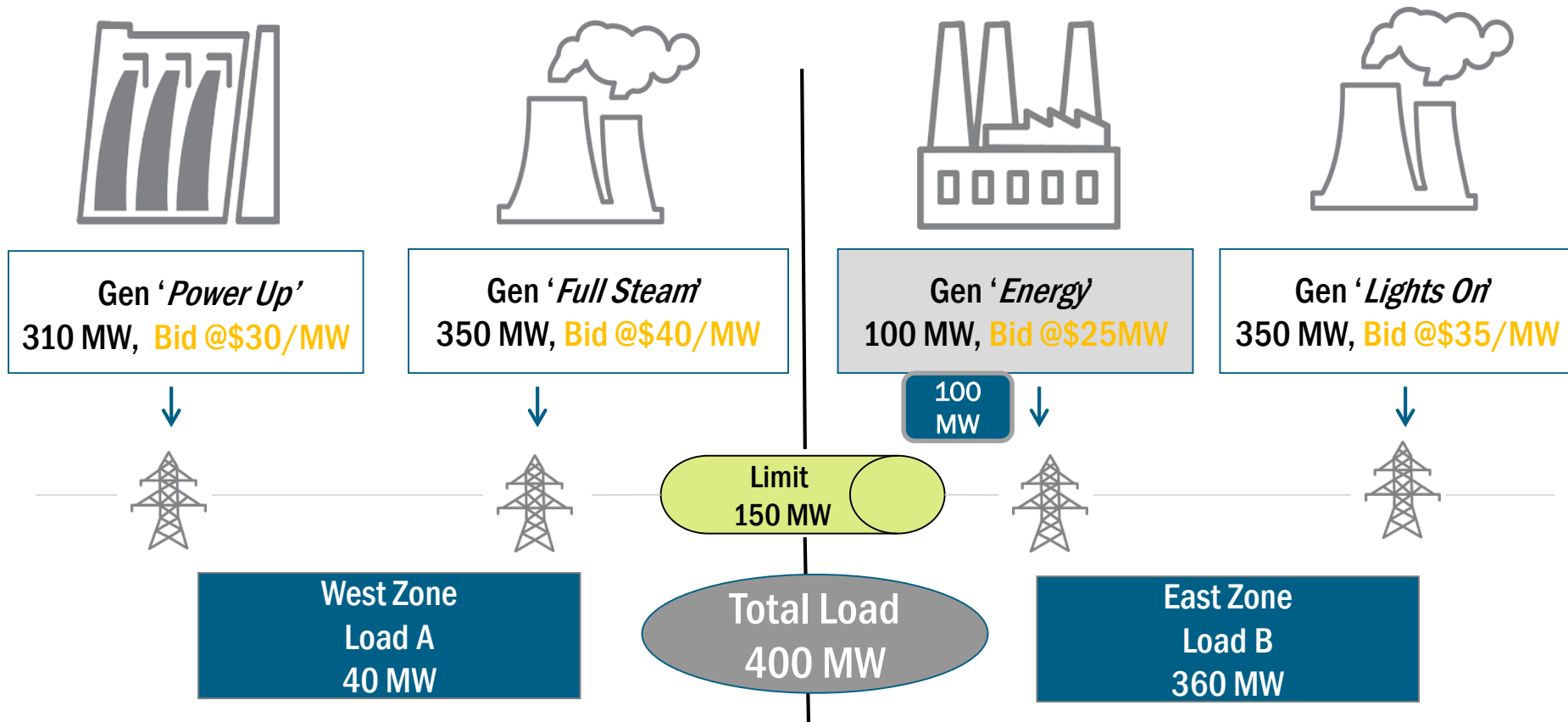


**Total Load = 400 MW**

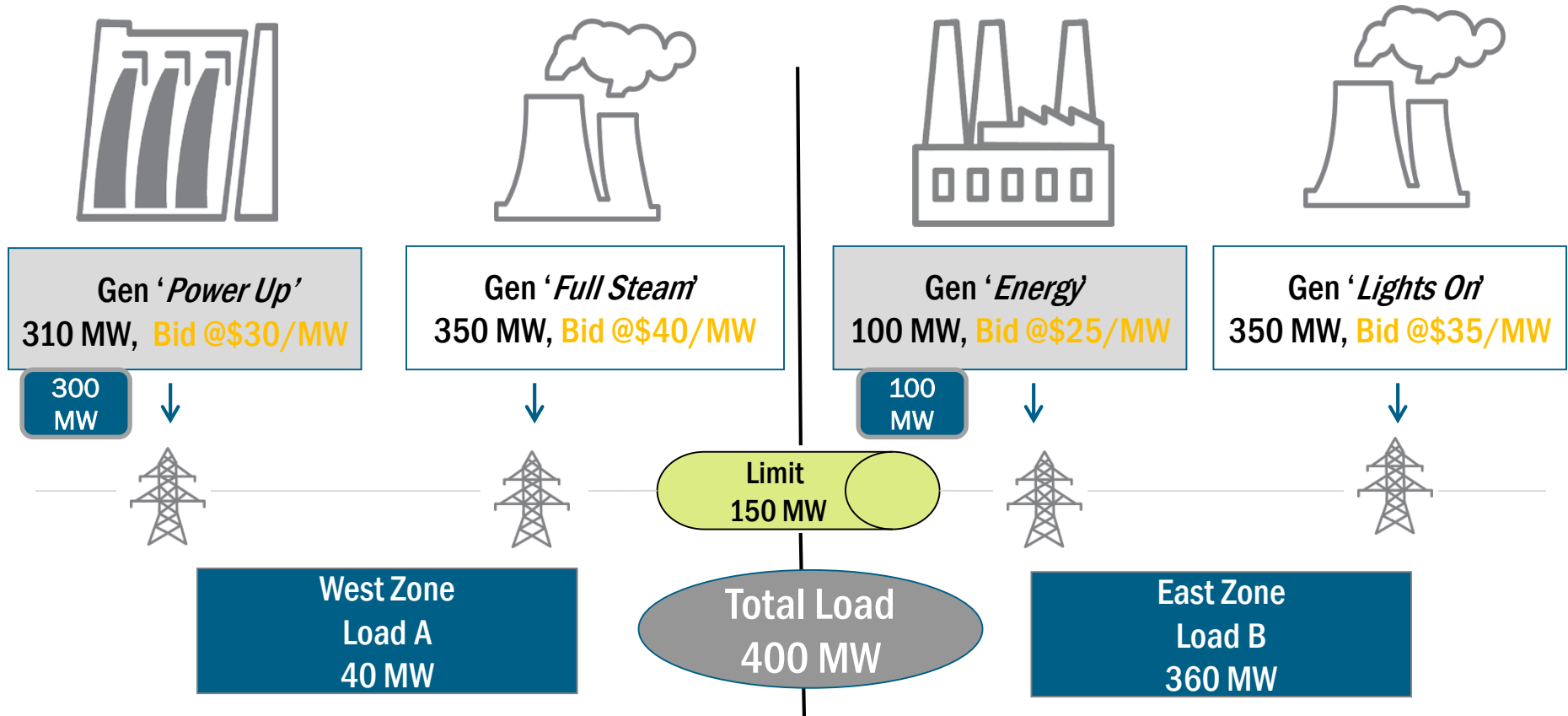
# Example 3: Energy and Congestion



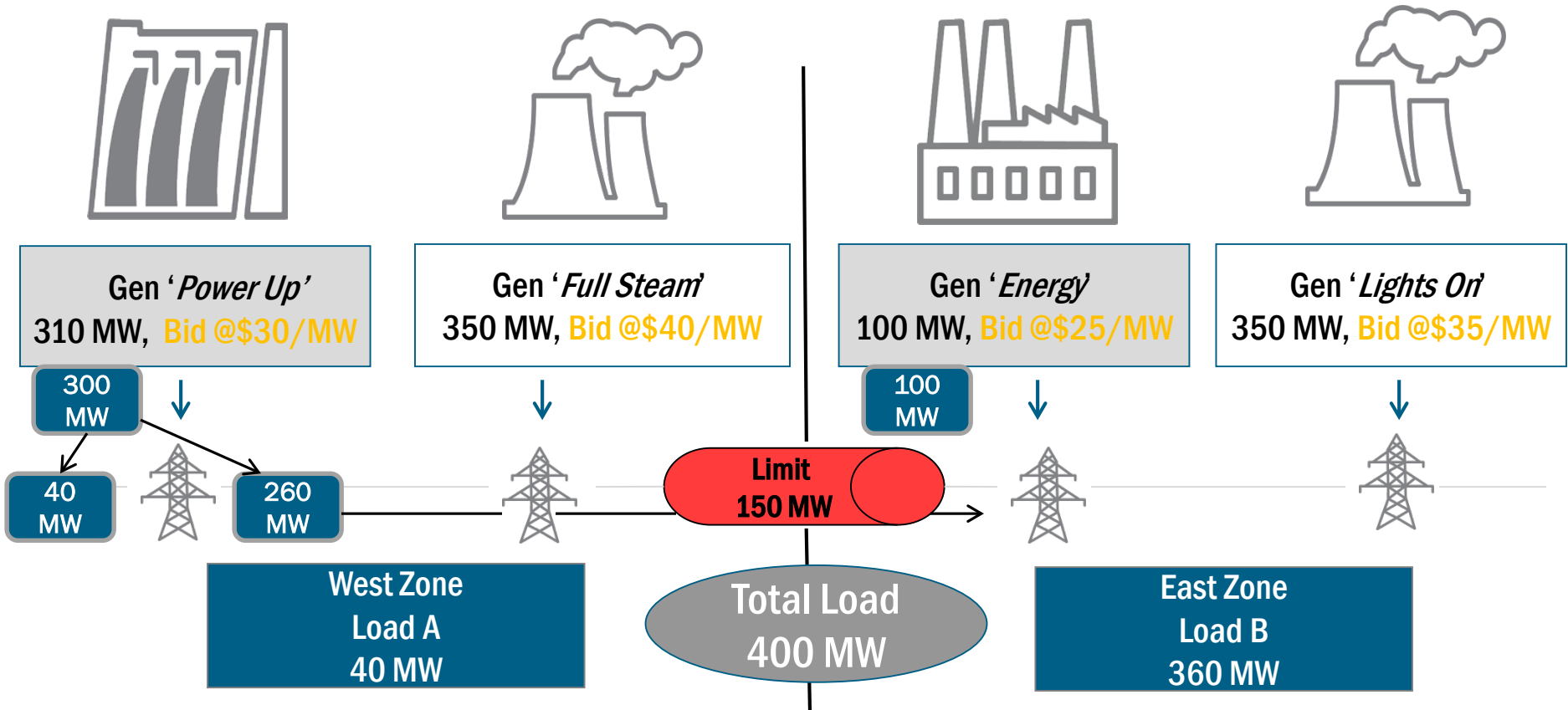
# Example 3: Energy and Congestion



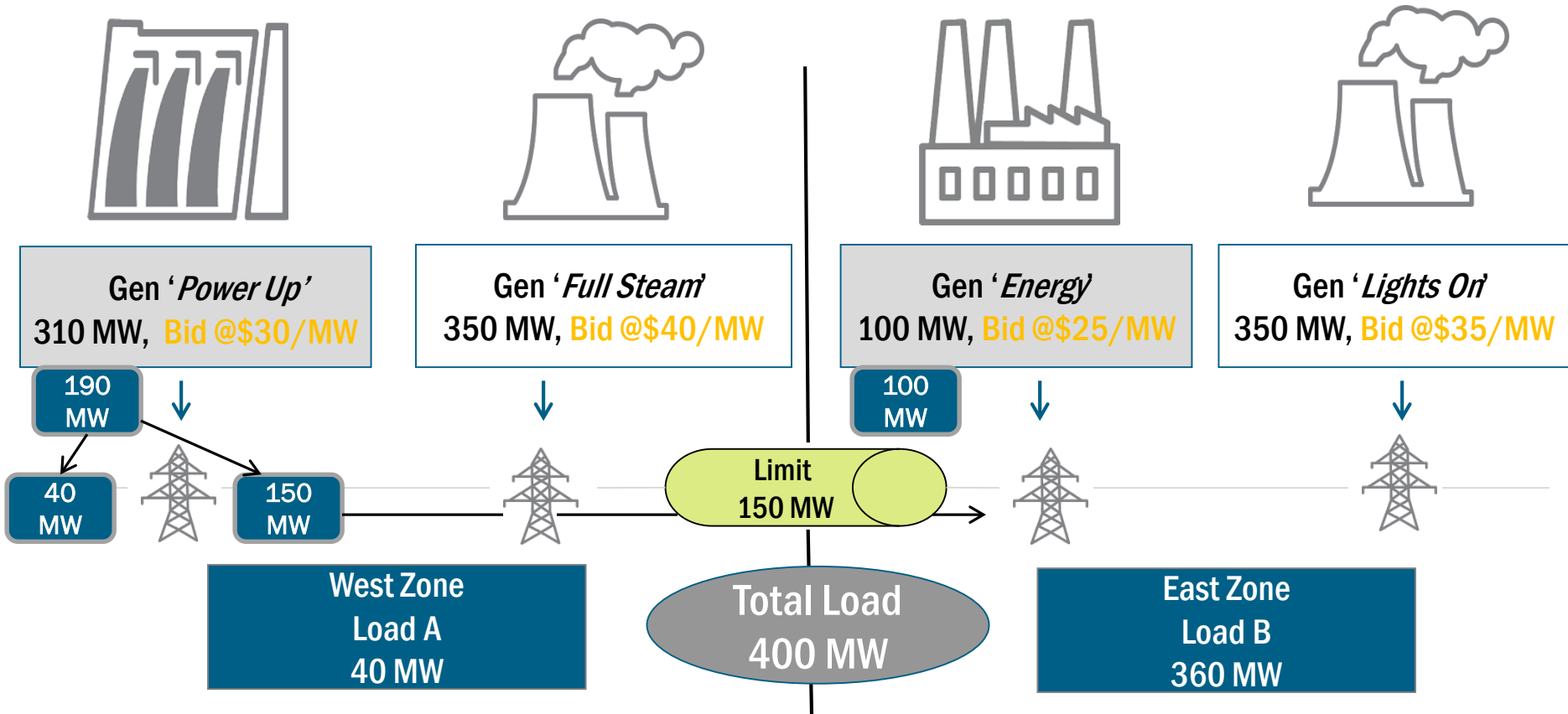
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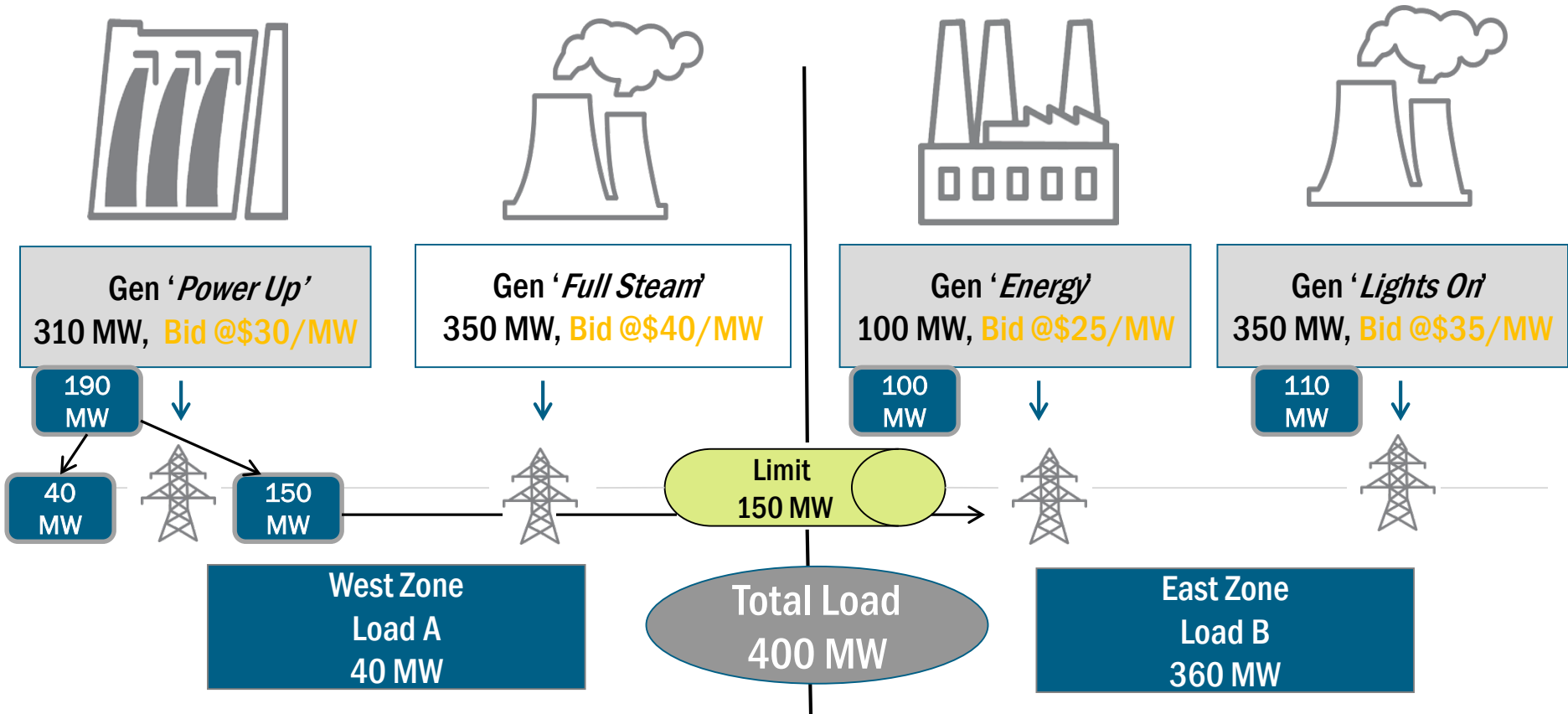
# Example 3: Energy and Congestion



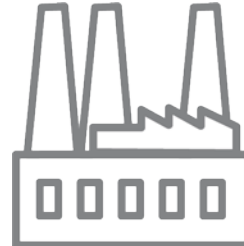
# Example 3: Energy and Congestion



# 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



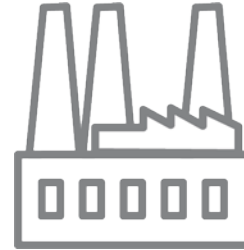
# Example 3: Energy and Congestion -Results



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)

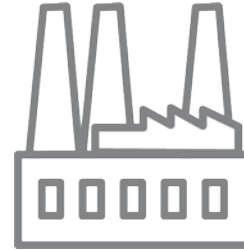
# Example 3: Energy and Congestion -Results



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 On', 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

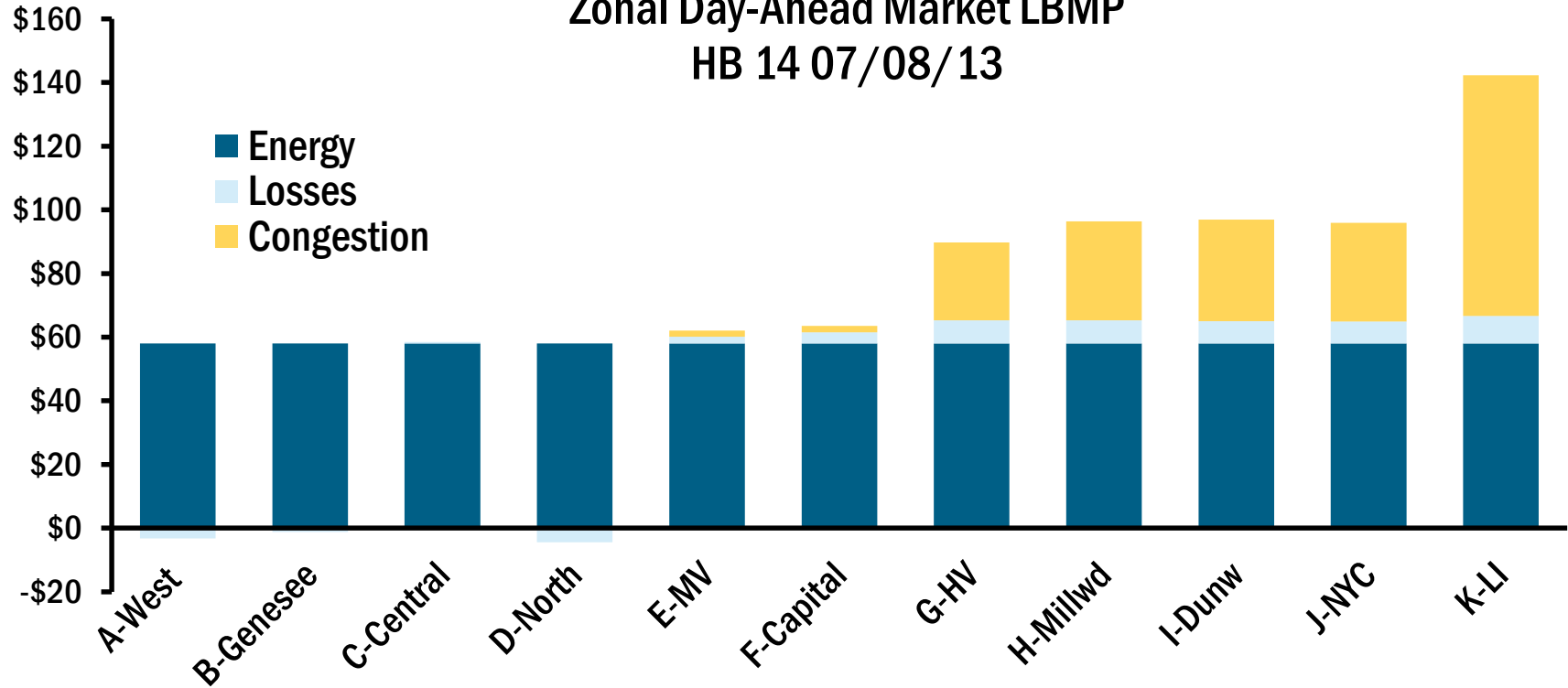
Loads in East Zone  
Charged \$35/MW (LBMP)



East Zone  
Load B  
360 MW

# Day Ahead LBMP- Zonal pattern for 1 hour

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

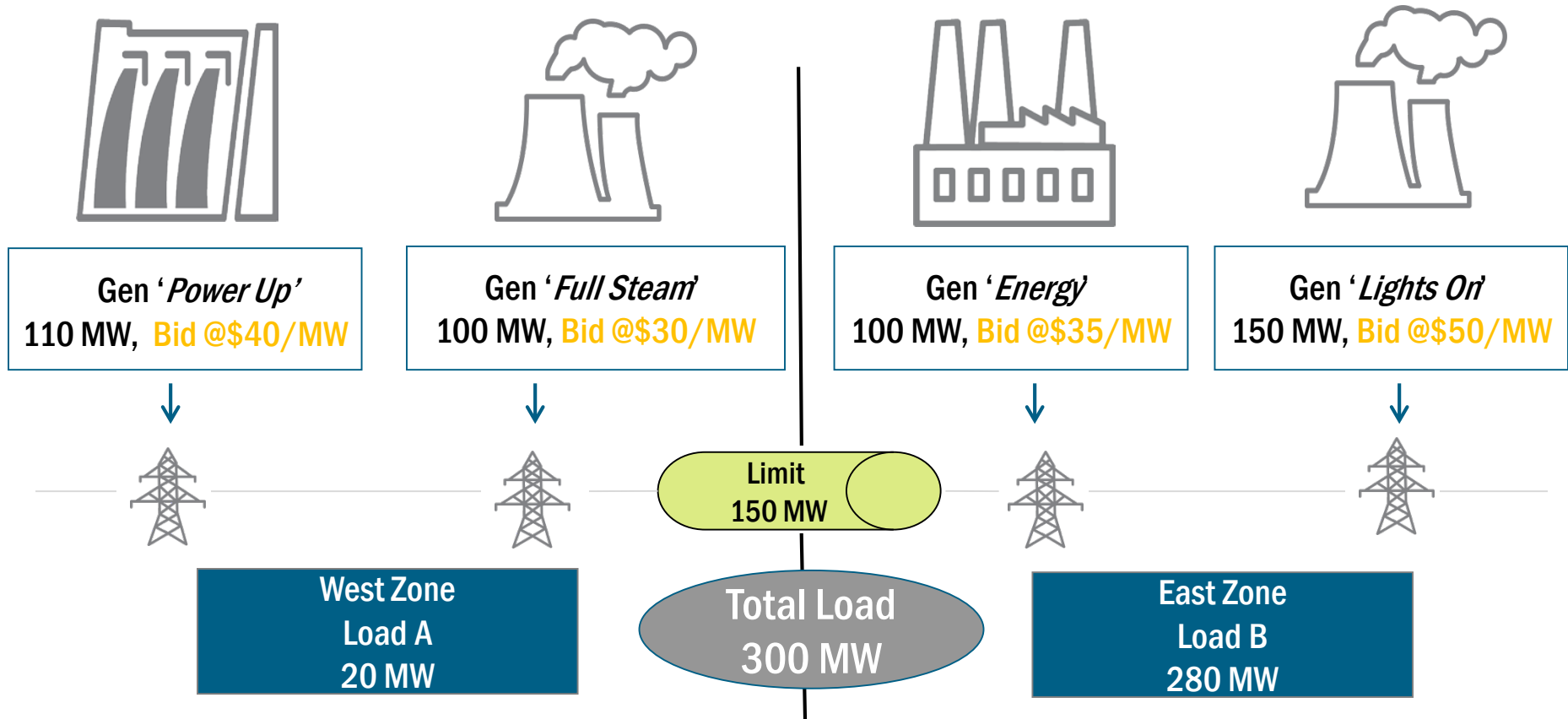


# Example 4: Energy and Congestion, No Losses

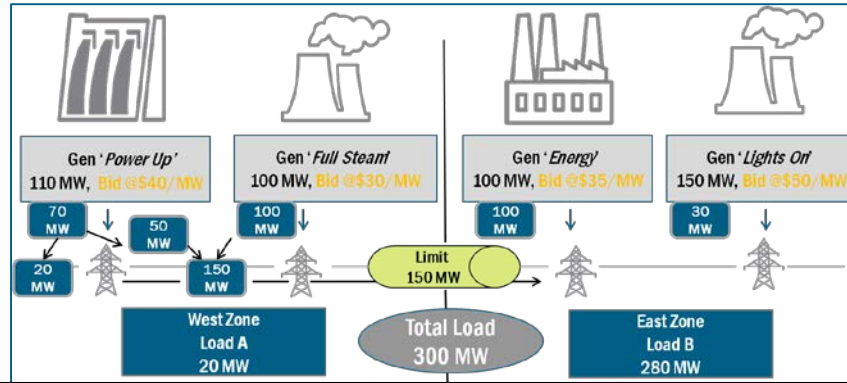


**Total Load = 300 MW**

# 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 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

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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