# Congestion Price Component


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## LBMP In-Depth Course

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# Session Topics

- Transfer Capability, Limitations & System Constraints
- System Constraints leading to Congestion Settlements
- Tariff Congestion Calculation
- Application of Congestion Calculation

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# Session Objectives

- Upon completion of this module, trainees will be able to:
  - Describe transfer limitation of power and common constraint points within the NYCA
  - Identify the three types of factors that can impact congestion price
  - State the components of the tariff congestion price calculation

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# LBMP Formula

**LBMP = Energy + Loss - Congestion**

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# Transfer Capability, Limitations & System Constraints

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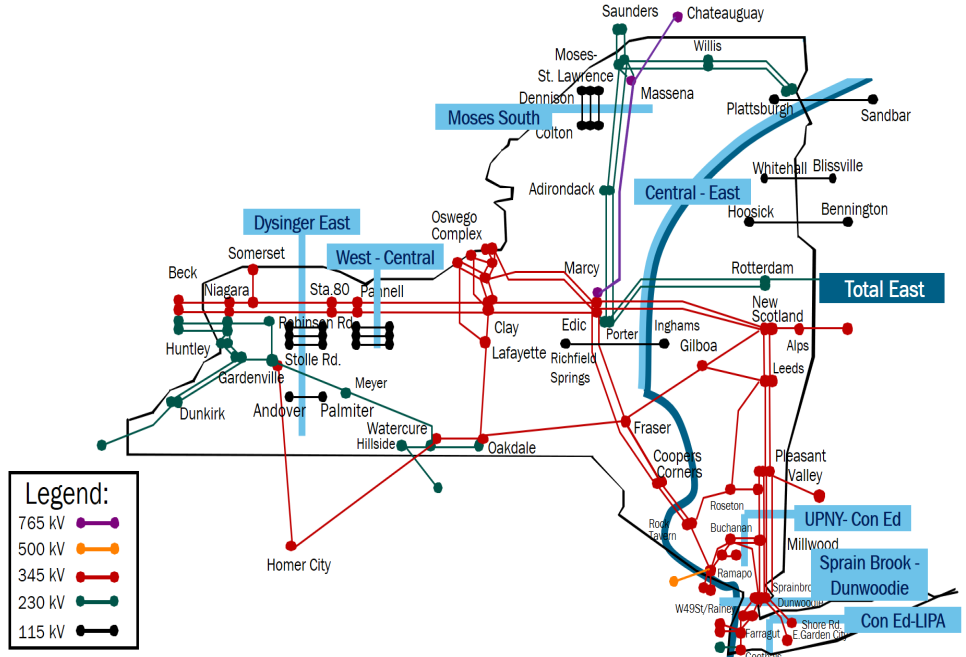
# Transfer Capability

- Transmission Line
  - Conductors designed to carry energy over large distances
- Transmission Interface*
  - A defined set of transmission lines that separate Load Zones and that separate the NYCA from adjacent Control Areas
  - Multiple transmission lines make up an interface
- Transfer Capability
  - Measure of the ability of interconnected electrical systems to reliably move or transfer power from one area to another over all transmission lines




* Not all NYCA internal interfaces shown here

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# Transfer Limitations & System Constraints

- Transfer limits create constraints on the flow of energy
  - Three types of Transfer Limits
  - Lowest of the three sets Transfer Capability

  **Total Transfer Capability = Min(Thermal Limit, Voltage Limit, Stability Limit)**
- Constraint
  - A limitation to the system that prevents optimal transfer of energy from generation to load
- Some interfaces have more impact on the flow of energy

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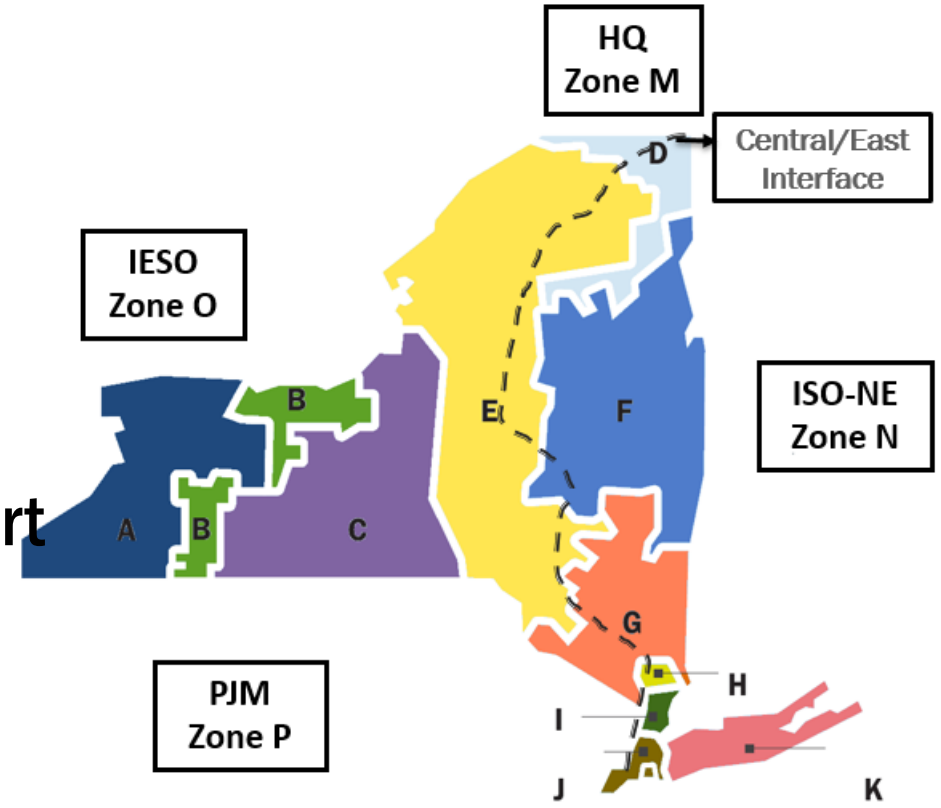
# Common Constraint Points

- NYCA contains unique locational characteristics
  - West
    - Susceptible to unscheduled flows from neighboring systems
  - Central/East
    - Limits transfer capability
- Certain locations are considered import or export constrained due to location
  - NYC (Import Constrained Area)
  - North (Export Constrained Area)

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# System constraints lead to congestion settlements

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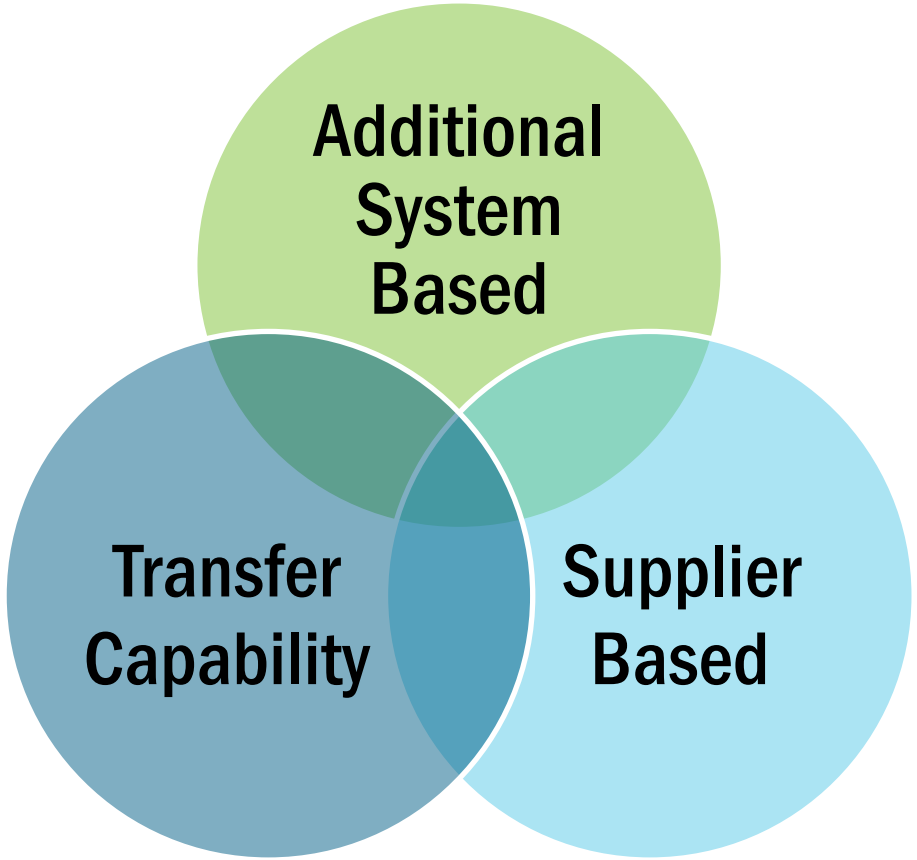
# Factors that Impact Congestion Price

- Three Categories of factors that can impact congestion price
  - Transfer Capability Factors
  - Supplier Based Factors
  - Additional System Based Factors
- Changing system conditions can alter supplier scheduling & dispatch
  - Creating/Impacting congestion within LBMPs

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# Transfer Capability Factors

| | Description |
|---|---|
| Thermal Limits | (Summer/Winter MW Ratings):<br>• Normal<br>• Long Term Emergency (LTE)<br>• Short Term Emergency (STE) |
| Voltage Limits | kV Ratings; Varies on equipment in service<br>• Pre-contingency High/Low<br>• Post-contingency High/Low |
| Stability Limits | MW Ratings; Varies on lines in-service or load on selected lines |
| Phase Angle Regulators (PARs) | Controls the transfer of power over the circuits |
| Transmission Outage | Planned and/or unexpected changes to the operational ability of a transmission facility; reducing power transfer capability |

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# Supplier Based Factors

| | Description |
|---|---|
| Generator Derates | Reduced generator output; may be scheduled or unscheduled |
| Generator Outages | Generator is off-line and out of service; may be scheduled or unscheduled |
| Out-of-Merit (OOM) Request | Out-of-Merit Generation, either up or down, can be requested by the NYISO and/or Transmission Owner (TO) for security of the bulk power system |
| Resource Bidding | Includes three overall bid components evaluated to determine supplier schedules: Unit Offer Parameters, Incremental Energy Offer, and Unit Operating Mode |
| Self-Scheduling | Part of operating mode selected by market participants seeking to operate a resource to meet an obligation outside of the wholesale markets, such as to meet a TO reliability need or running the unit to perform testing |
| Supplemental Resource Evaluation (SRE) Request | Determination of the least cost selection of additional generators, which are to be committed, to meet changed or local system conditions for Dispatch Day to meet reliability requirements for the Transmission Owner's (TO's) local system or to meet load requirements of the ISO |

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# Additional System Based Factors

| | Description |
|---|---|
| Transaction Curtailments | Energy transactions are monitored on an on-going basis and reduced in real time to address grid security issues |
| Thunderstorm Alerts (TSA) | Severe weather conditions in Zone J (NYC) causing generation to be scheduled and dispatched differently |
| Reserve Shortage | Shortages for the NYCA statewide region, locational shortages within the NYCA, or inter-regional locational shortages between NYCA and neighboring Control Areas |
| Operating States | The NYISO determines the state of NYS Power System by comparing system conditions against certain monitoring criteria. For instance, if a transmission facility becomes overloaded, relief measures are applied immediately to bring the loading within established ratings |

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# Tariff Congestion Calculation

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# LBMP Congestion: Generator Calculation

- Congestion Component for a generator is calculated at the generator bus

Gen Bus LBMP Congestion Component =

- {Sum $_{\text{for set of constraints}}$ [(Generator Shift Factor $_{\text{on each constraint}}$) * (Shadow Price $_{\text{of constraint}}$)]}

***Except as noted in Sections 17.1.2.2.1 and 17.1.2.3.1 of this Attachment B

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# LBMP Congestion: Generator Shift Factor

- Shift Factor Defined
  - A ratio, calculated by the ISO, that compares the change in power flow through a transmission facility resulting from the incremental injection and withdrawal of power on the NYS Transmission System
  - Calculated with respect to the Reference Bus (Marcy)
  - Shift Factor could be positive or negative

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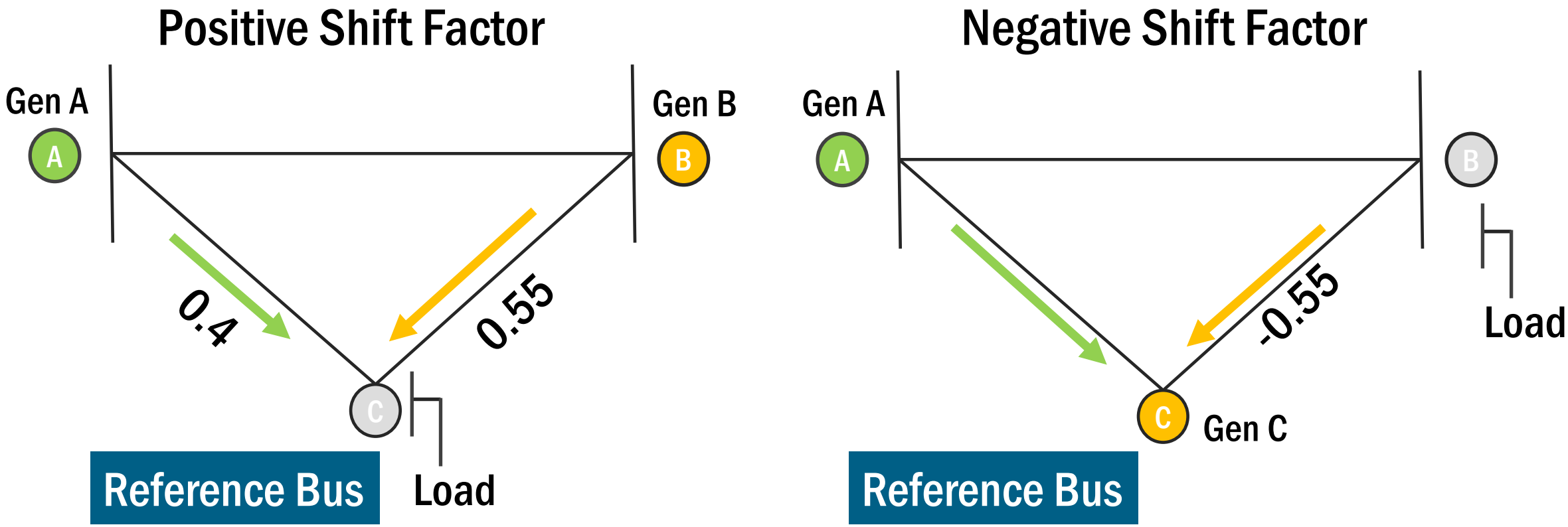
# LBMP Congestion: Generator Shift Factor

- Example -

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# LBMP Congestion: Generator Shift Factor cont'd

- Shift Factor Determination
  - Determined dynamically by SCUC, RTC and RTD as part of the power flow solution for each time interval
  - Factors considered:
    - Network Topology
    - Expected Power Flows
    - Expected Unscheduled Power Flows
    - Internal and Coordinated External Transmission Facility Outages

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# LBMP Congestion: Generator Shadow Price

- Shadow Pricing Defined
  - Value of relieving a particular constraint which is determined by the reduction in as-bid system production cost that results from:
    - An incremental relaxation of that constraint; or
    - The application of shortage pricing mechanisms, such as Transmission Constraint Pricing, when supply is unavailable to resolve the constraint
  - Expressed in $/MWh

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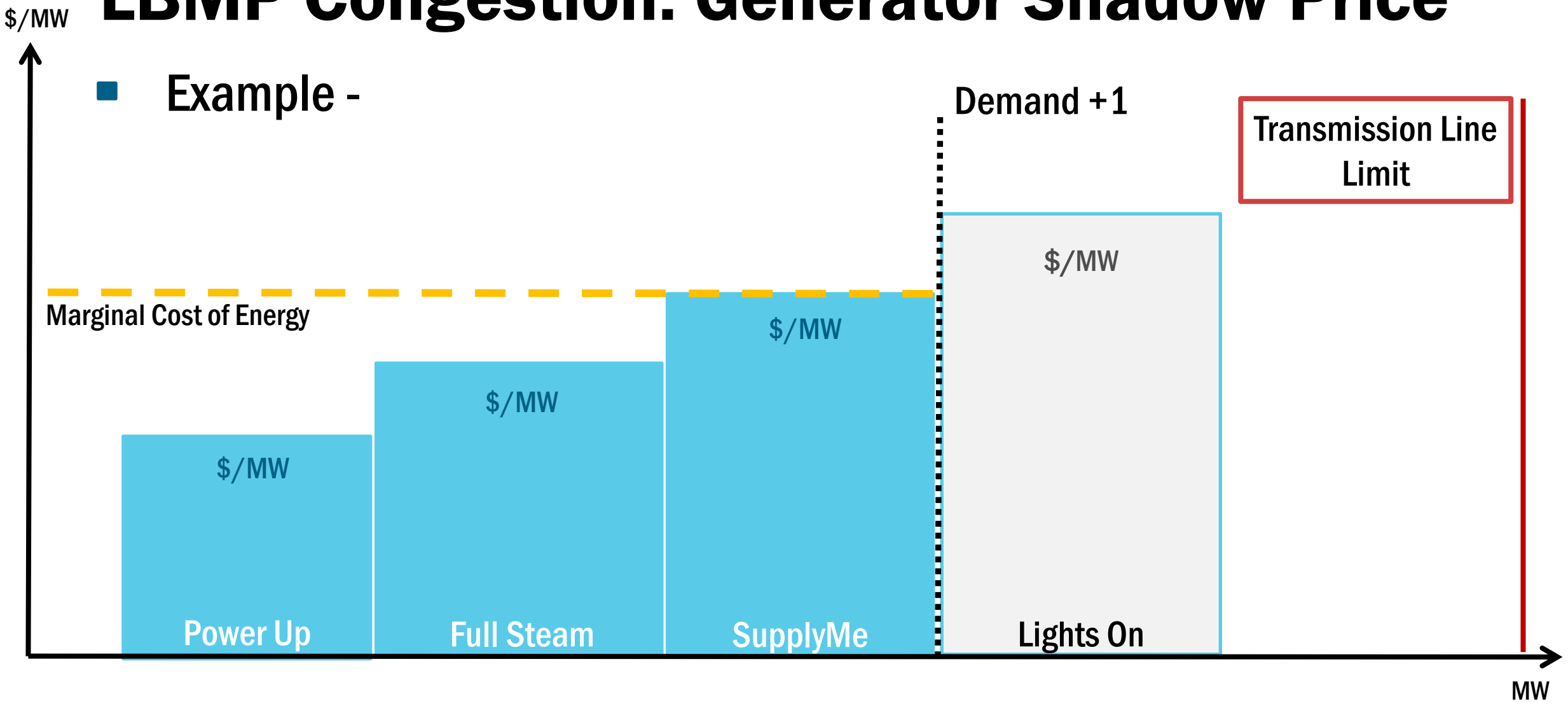
# LBMP Congestion: Generator Shadow Price

- Example -

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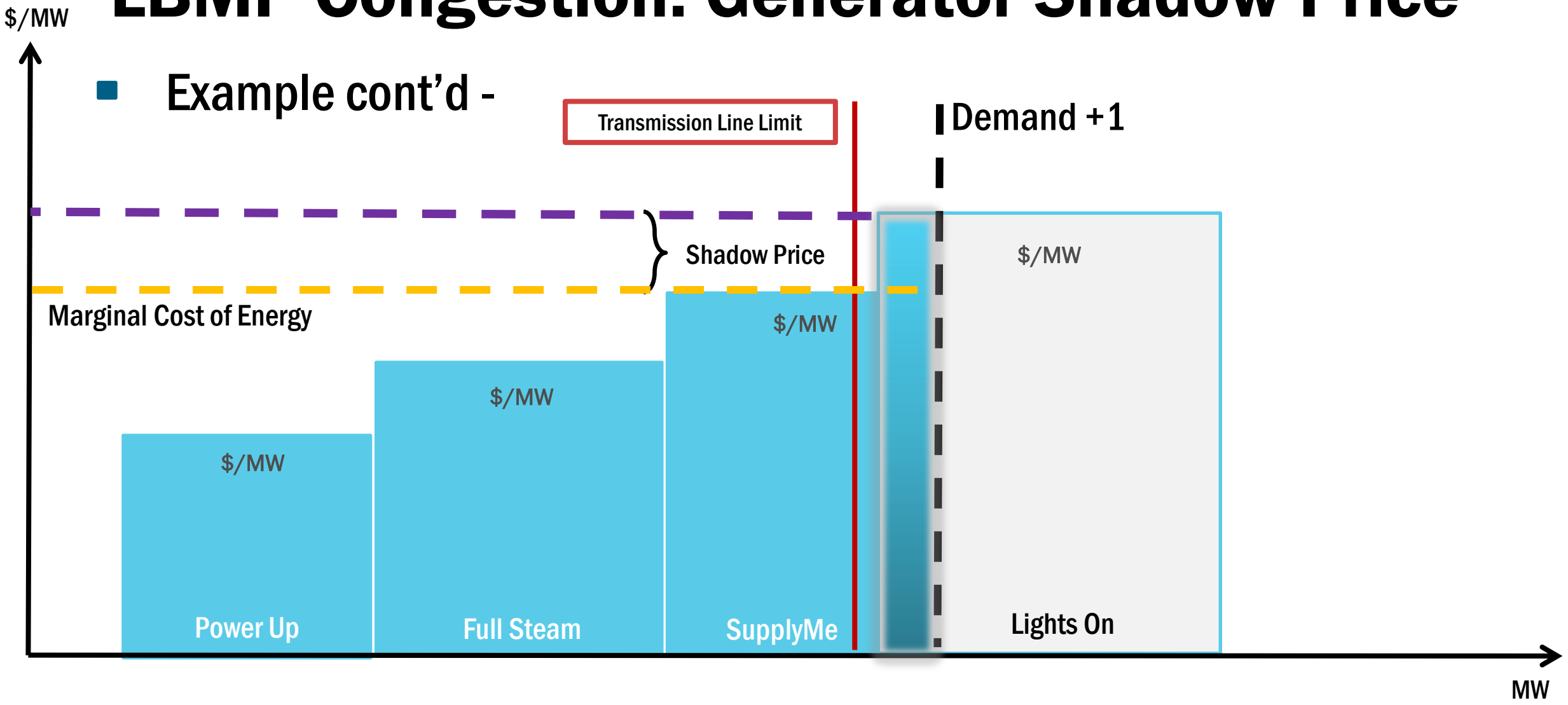
# LBMP Congestion: Generator Shadow Price

- Example cont'd -

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# Let's Review

Transfer limits across NYCA's external interfaces set the MW availability limit to schedule import or export scheduled power transactions between RTO/ISOs

True

False

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# Let’s Review

An area with low demand, high generation, and limited Transmission capability to move the MWs out of there to other areas in the NYCA is an

Import constrained area

Export constrained area

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# Let's Review

The factor that is not considered in the calculation of generator shift factor is:

a. Network topology

b. Expected Power Flows

c. Expected Unscheduled Power Flows

d. Internal and Coordinated External Transmission Facility Outages

e. Scheduled Generator outages

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# Generator Congestion Calculation - Summary Example

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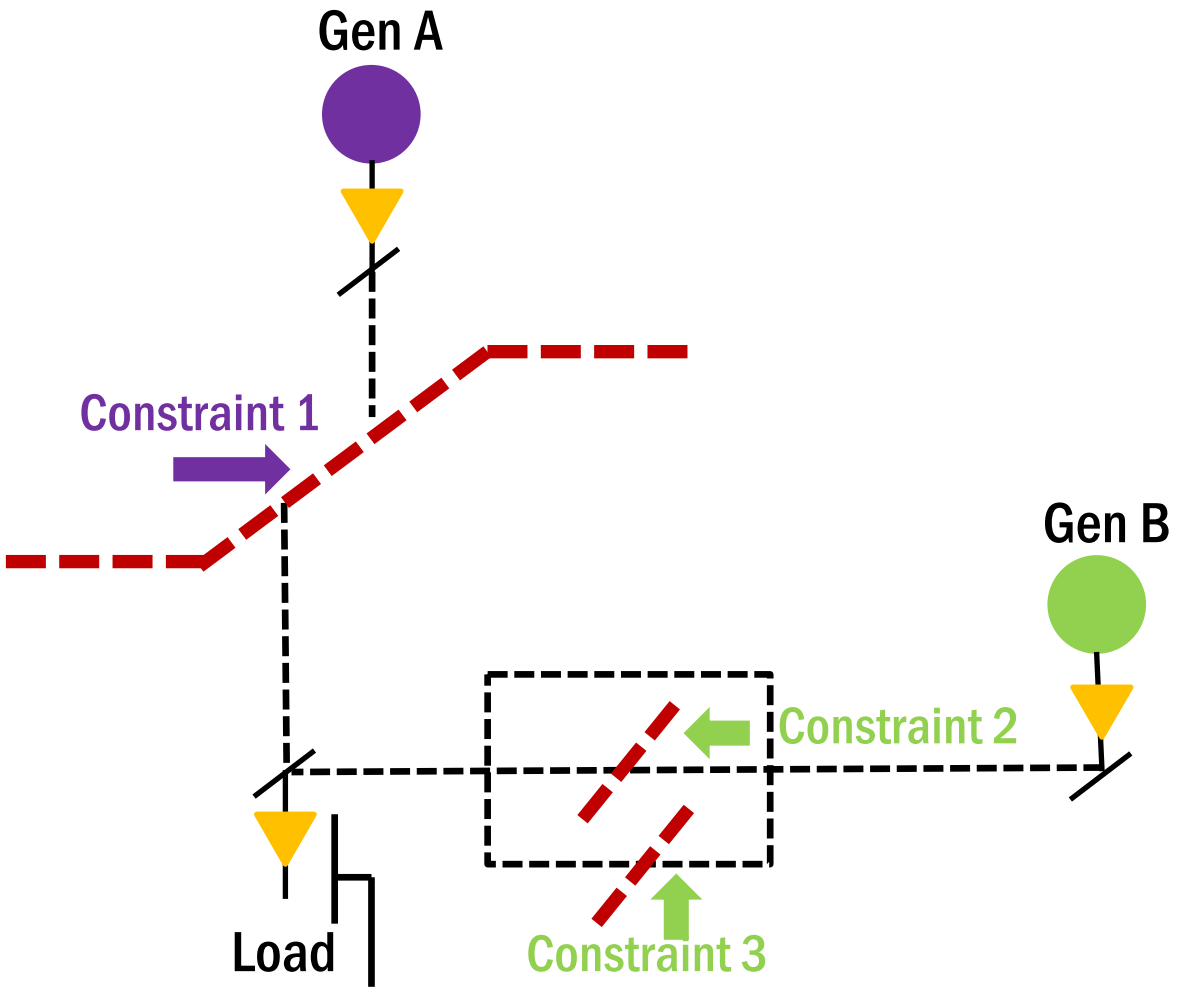
# Congestion on the Transmission System

For a representative hour solved by SCUC

| Gen A | Constraint 1 |
|---|---|
| Shift Factor | -0.400324 |
| Shadow Price | -$150.79 |

| Gen B | Constraint 2 | Constraint 3 |
|---|---|---|
| Shift Factor | -0.085097 | -0.19467 |
| Shadow Price | $67.42 | $153.11 |

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# Congestion on the Transmission System

For a representative hour solved by SCUC

| Gen A | Constraint 1 |
|---|---|
| Shift Factor | -0.400324 |
| Shadow Price | -$150.79 |

Congestion Component ($) = - { -0.400324 x -150.79}

= - $60.36 x -1

= $60.36

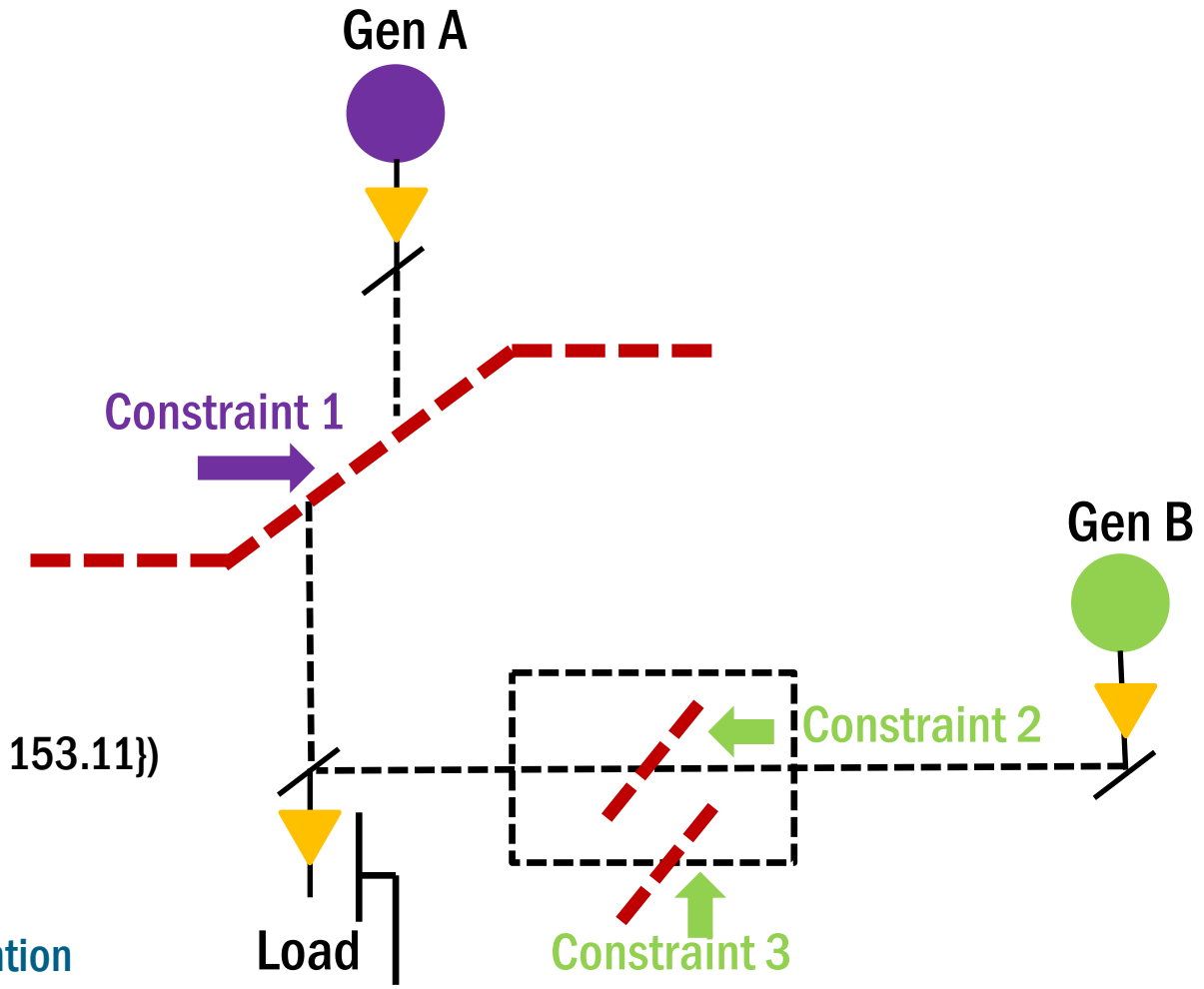
| Gen B | Constraint 2 | Constraint 3 |
|---|---|---|
| Shift Factor | -0.085097 | -0.19467 |
| Shadow Price | $67.42 | $153.11 |

Congestion Component ($) = - {(-0.085097 x 67.42) + (-0.19467 x 153.11})

= $35.53 x -1

= -$35.53

Note: Congestion value multiplied by -1 as per NYISO Settlement convention

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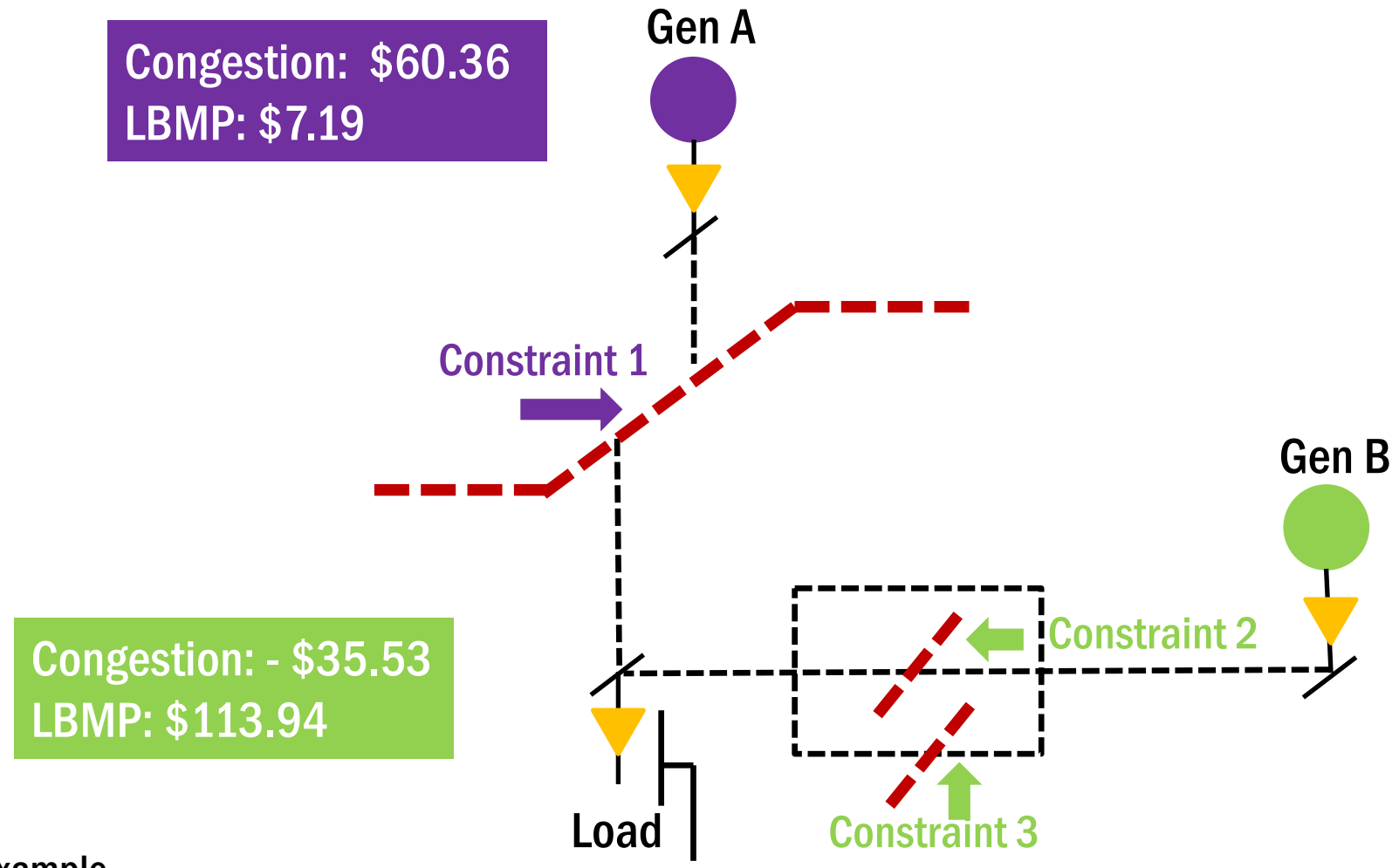
# Congestion on the Transmission System

For a representative hour solved by SCUC

Marginal Price of Energy = $72.40




Note: Losses are non-zero for this example

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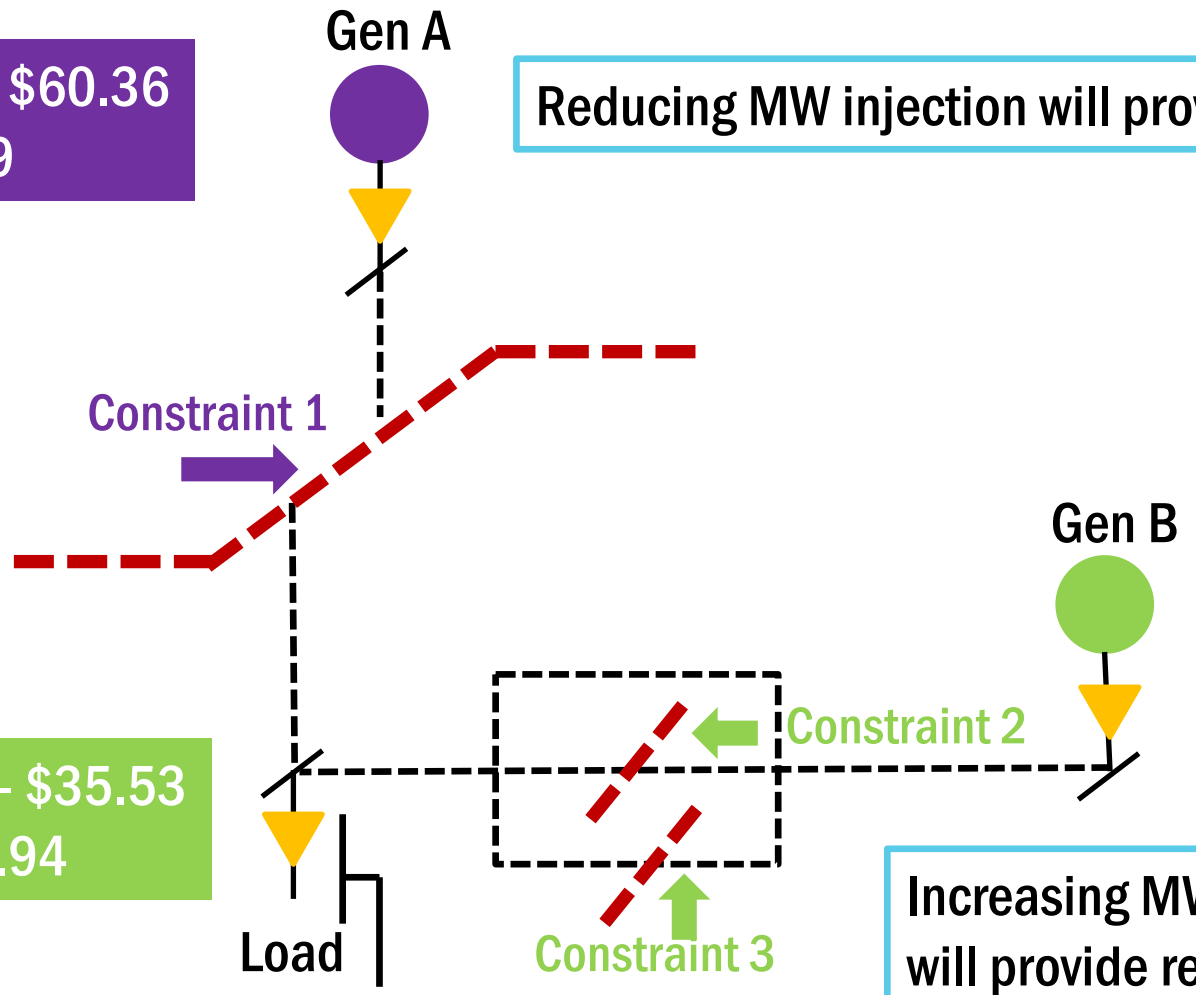
# Congestion on the Transmission System

For a representative hour solved by SCUC

Marginal Price of Energy = $72.40

Congestion: $60.36
LBMP: $7.19

Reducing MW injection will provide relief




Generator injection could aggravate or relieve a constraint

Congestion: - $35.53
LBMP: $113.94

Increasing MW injection will provide relief

Note: Losses are non-zero for this example

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# Transmission Constraint Pricing

- Constraint Reliability Margin (CRM) assigned by NYISO to help manage transmission modeling uncertainty
  - Assigned to facilities and interfaces
    - Zero or non-zero value
  - Represents value below maximum physical limit on a transmission facility/ Interface that is used by SCUC, RTC and RTD as the effective limit when evaluating for economic commitment and dispatch
  - Identified facilities: Certain internal transmission facilities that accommodate power flows out of export constrained areas
- Shadow Prices are applied in instances of transmission shortages

Section 7.3.7, T and D Manual

**Graduated Transmission Demand Curves, as of October 2023**

| NY Region | Type | Demand Curve (MW) | Demand Curve Price ($/MWh) |
|---|---|---|---|
| All | Facilities/Interfaces other than Identified Facilities with a non-zero CRM value | 1. MW value equivalent to 20% of the applicable CRM<br>2. MW value equivalent to an additional 20% of the applicable CRM<br>3. MW value equivalent to an additional 20% of the applicable CRM<br>4. MW value equivalent to an additional 20% of the applicable CRM<br>5. MW value equivalent to the remaining 20% of the applicable CRM<br>6. Any MW value greater than the applicable CRM | 1. $200<br>2. $350<br>3. $600<br>4. $1,500<br>5. $2,500<br>6. $4,000 |
| All | Identified Facilities | 1. MW value equivalent to the applicable CRM<br>2. Any MW value greater than the applicable CRM | 1. $100<br>2. $250 |
| All | Facilities/Interfaces with a zero CRM value | | $4,000 |

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# LBMP Congestion: Load Calculation

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# LBMP Congestion: Load Calculation

- Congestion Component for Load is calculated at the respective load zone
  - Congestion for a zone will be a Load weighted average of the Load buses in the Load Zone, rendering one zonal congestion for entire zone
    - Load weights which will sum to unity will be calculated from the load bus MW distribution

Zonal LBMP Congestion Component = ∑of each bus (Load Bus Weighting * Marginal Load Bus Congestion)

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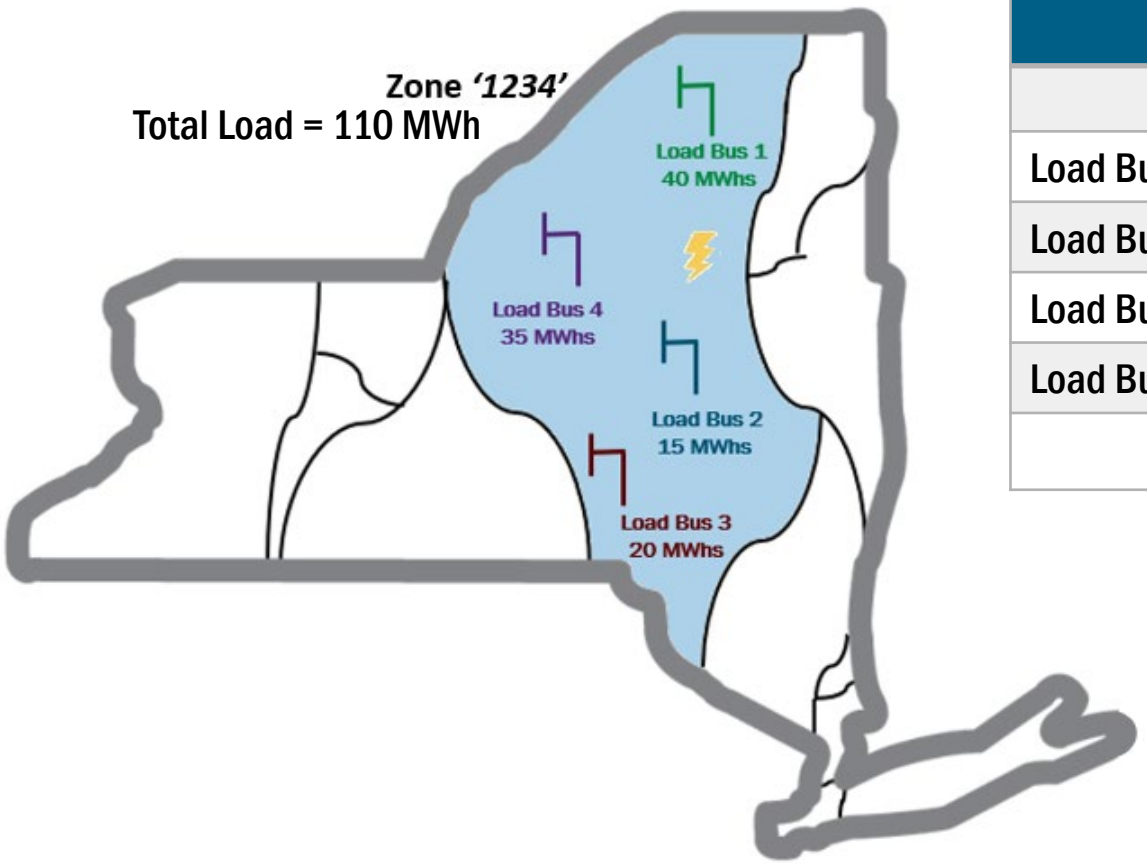
# Load Congestion Calculation – Summary Example




| Calculating Zonal Congestion using Load Weighted Average | | | |
|---|---|---|---|
| | Load Weighted Value | Congestion Price | Weighted Congestion Price |
| Load Bus 1 | 40/110 = 0.36 | $12 | $4.32 |
| Load Bus 2 | 15/110 = 0.14 | $10 | $1.40 |
| Load Bus 3 | 20/110 = 0.18 | $13 | $2.34 |
| Load Bus 4 | 35/110 = 0.32 | $15 | $4.80 |
| Zone '*1234*' Congestion Price Component | | | $12.86 |

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# Application of Congestion Calculation

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# LBMP Congestion: Real World Example

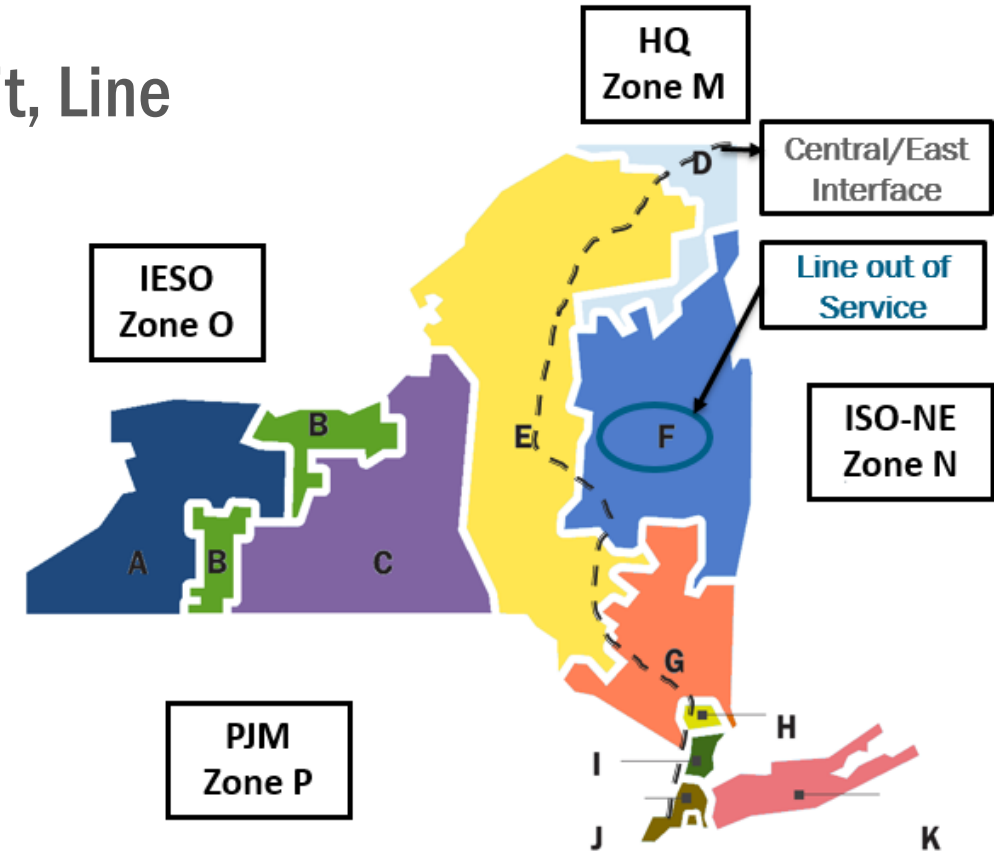
- Interface Limit – Central/East
  - Congestion Factor: Transfer Capability Limit, Line Outage
  - Scenario:

    02/10/2021 RTD Interval 01:25 through 01:55: Spike in congestion started due to outage in Capital Zone

    – Impacted transfer limit on Central/East interface

    » Majority of NYCA zonal LBMPs affected

    – RTD CAM re-dispatched to adjust to system limits on interface

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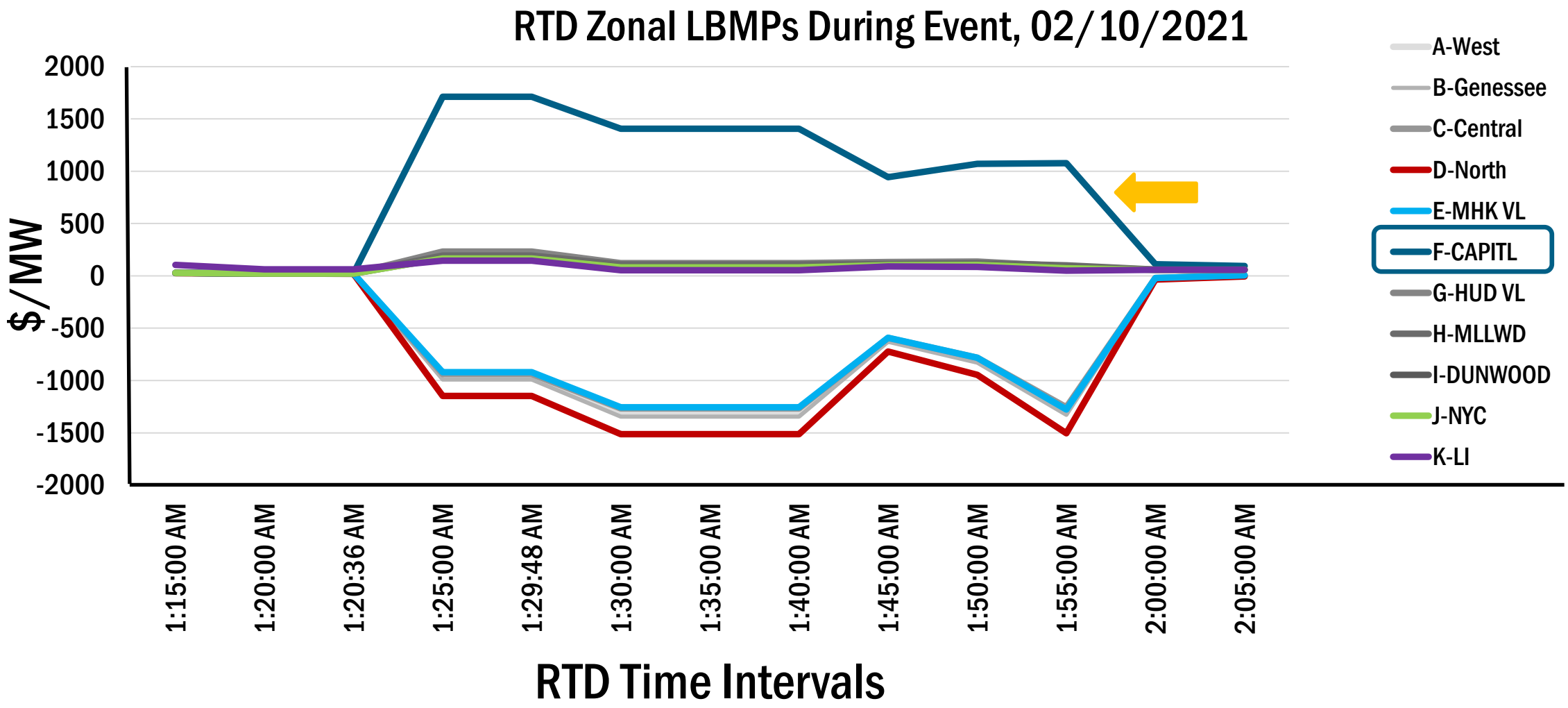
# LBMP Congestion: Real World Example cont'd

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# Summary of Congestion Price Component

- Transfer limitation of power
- Common constraint points within the NYCA
- Three types of factors that can impact congestion price
- The components of the tariff congestion price calculation

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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

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