Operating Reserves Overview

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DIRS

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What are Operating Reserves?

- "**Operations**" Definition of Operating Reserves
  - "Extra" available generation that is scheduled on day-ahead basis and maintained in real-time
  - Defined in
    - PJM Pre-Scheduling Manual (M-10)
    - PJM Emergency Ops Manual (M-13)
- "**Settlements**" Definition of Operating Reserves
  - "Make-whole" payments to pool-scheduled resources and transactions
  - Defined in Operating Agreement
    - Schedule 1-3.2.3 &3.3.3
- This training module focuses on settlements definition of Operating Reserves

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Operating Reserves

- Accounting for Operating Reserve is performed daily
- Pool-scheduled resource is eligible to receive credits for providing Operating Reserve in day-ahead market and, provided that resource is available for entire time specified in its offer data, in balancing market
- Total resource offer amount for generation, including startup and no-load costs as applicable, is compared to its **Total Energy Market Value** for specified operating period segments during day
  - If Energy Market Value < Offer Amount, difference is credited to PJM Member

Total Energy Market Value

- ***Any amounts credited for …***
  - **Day-ahead scheduling reserve in excess of day-ahead scheduling reserve offer plus opportunity cost**
  - **Synchronized reserve in excess of synchronized reserve offer plus opportunity cost**
  - **Non-synchronized reserve in excess of opportunity cost**
  - **Resources providing reactive services**

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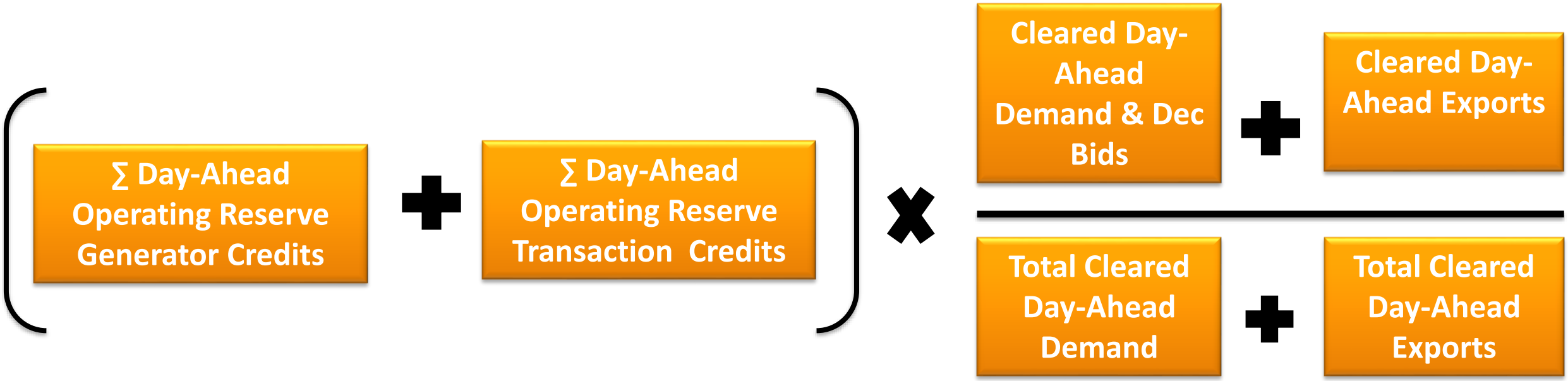
Day-Ahead Operating Reserve Charges (BLI 1370)

- Daily total cost of Day-ahead Operating Reserve excluding total cost for resources scheduled to provide Black Start Service, Reactive Services, or transfer interface control, is allocated in proportion to cleared day-ahead demand and decrement bids plus cleared day-ahead exports
- Total daily cost of Day-ahead Operating Reserve for resources scheduled to provide Reactive Services or transfer interface control because resource is known or expected to be needed to maintain system reliability in zone(s) is allocated and charged in proportion to total real-time load in applicable transmission zone(s)



Balancing Operating Reserve Cost Analysis (BORCA)

- PJM conducts BORCA to determine reason why Operating Reserve credit is earned so charges can be properly allocated
- PJM also calculates Regional Balancing Operating rate for cost of Operating Reserves that result from actions to control transmission constraints that are solely within pre-defined regions in RTO
  - BOR credits associated with constraint of ≤ 345kV are allocated regionally
- Additional costs of Operating Reserves that result from actions to control transmission constraints that benefit entire RTO are allocated equally to deviations across entire RTO

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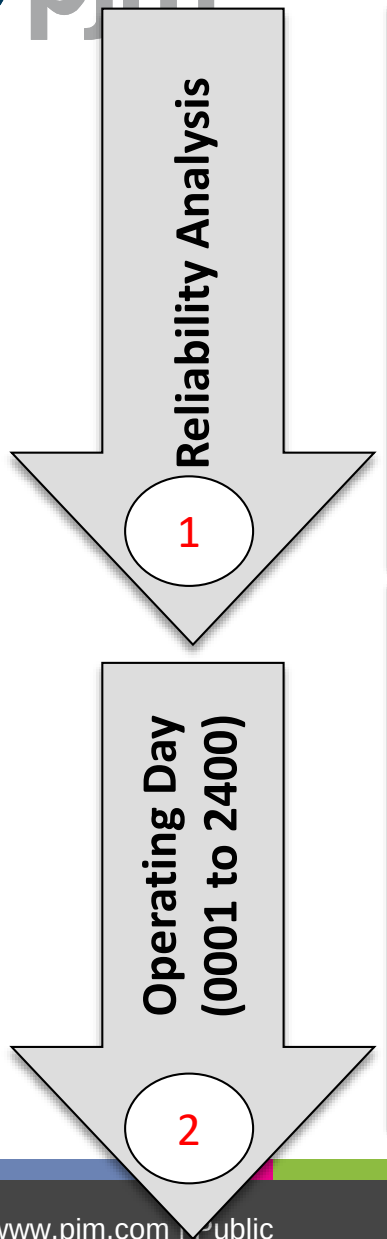
Balancing Operating Reserve Cost Allocation (BORCA)



Reliability Analysis (RA) BORCA

RA BOR Credits for Reliability

Units committed due to extenuating conditions that warrant conservative actions to ensure maintenance of system reliability (i.e. to provide reserves over and above quantity determined by real-time load forecast)

RA BOR Credits for Deviations

Units committed to operate in real-time to augment physical units committed in Day-Ahead Market to meet forecasted real-time load, plus operating reserve requirement

Real-Time (RT) BORCA

RT BOR Credits for Reliability

Units started PJM to operate during operating day for which LMP at unit's bus does not meet or exceed unit's applicable offer (cost or price) for at least 4, 5-minute intervals of at least one clock hour during which unit was running at PJM's direction

RT BOR Credits for Deviations

All other units operated at PJM's direction in real-time

Load Ratio Share plus exports

Real-Time Deviations from Day-Ahead Schedules

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Ramp-Limited Desired MW Calculation for Deviations

- Create greater incentive for generators to follow PJM real-time dispatch instruction rather than day-ahead schedule
- Determination of generation deviations made using following criteria:
  - Ramp-Limited Desired MW
  - % Off Dispatch
  - MW Off Dispatch
- Once generator is deemed “deviating,” charges are based on operational characteristics of generator and …
  - Real Time MWh – Ramp Limited Desired MWh **OR**
  - Real Time MWh – UDS LMP Desired MWh **OR**
  - Real Time MWh – Day-Ahead MWh

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Definitions & Applicability

- Definitions
  - **UDS Basepoint** – Time weighted individual generator dispatch point (this value is ramp limited)
  - **Ramp Limited Desired (RLD) MW** – Achievable MW based on SCED requested ramp rate (this value is ramp-limited)
  - **UDS LMP Desired MWh** - Calculated by comparing hourly integrated SCED LMP to unit's bid curve to determine corresponding MW value (this value is not ramp-limited)
  - **Day-Ahead MWh** – Participants day-ahead market position
  - **% Off Dispatch** – Percentage off dispatch using lesser of (Actual Output - UDS Basepoint) OR (Actual Output - Ramp Limited Desired MW)
- Applicability
  - Day-ahead scheduled units
  - Reliability Assessment Run scheduled units
  - Must-Run units that are dispatchable and dispatched above Eco Min

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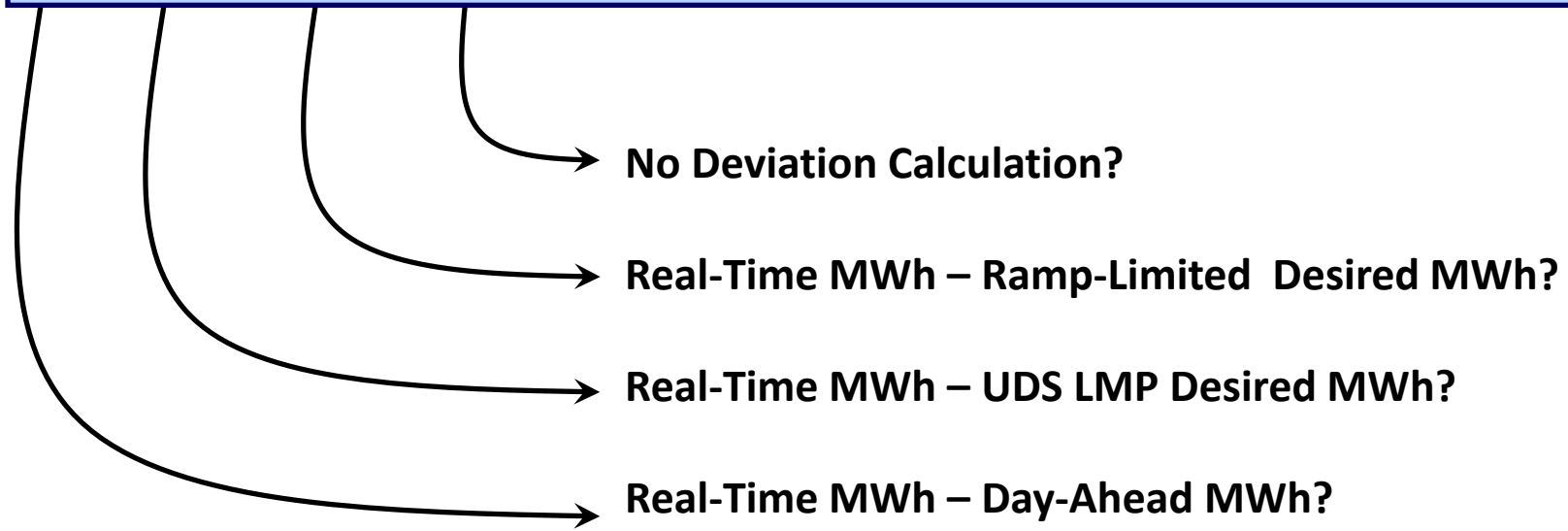
Operating Scenarios with Ramp-Limited Desired MW

Operating scenarios of generator determine if and how deviation is calculated



See Operating Agreement for more details

Resources Following Dispatch

Pool-scheduled and dispatchable self-scheduled resources operating above economic minimum are considered to be following dispatch if…

1. Actual output is between Ramp-Limited Desired MWh and UDS Basepoint, **OR**
2. % off dispatch is less than or equal to 10, **OR**
3. Hourly integrated Real-time MWh are within 5% or 5 MW (whichever is greater) of hourly integrated Ramp-Limited Desired MW

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Resources Not Following Dispatch

Pool-scheduled or dispatchable self-scheduled generator not following PJM dispatch due to…

1. Actual output not being between its ramp-limited Desired MWh and UDS Basepoint MWh **AND**
2. % off dispatch is > 10%

Assessed deviations as Real-time MWh – Ramp-limited Desired MWh

*If % off dispatch is > 20%, deviations are assessed as Real-time MWh – UDS LMP Desired MWh

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Resources Not Following Dispatch

Resources assessed deviations as Real-time MWh – Day-ahead Schedule MWh …

1. Self-scheduled generating resource has economic maximum limit ≤ 110% of economic minimum limit **OR**
2. Resource not dispatched by PJM above its economic minimum, unless it is lowering its output in accordance with PJM direction in response to minimum generation emergency event (or declaration)

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Resources Not Following Dispatch

Each unit that has day-ahead schedule and trips or is scheduled day-ahead and does not run in real-time is assessed deviations …

- Real-time MWh – Day-Ahead Scheduled MWh

Resources Not Dispatchable

- Each unit that is dispatchable day-ahead but is Fixed Gen in real-time is assessed deviations
  - Real-time MWh – UDS LMP Desired MWh
- Each unit that is not dispatchable in both day-ahead and real-time market is assessed deviations
  - Real-time MWh – Day-ahead Scheduled MWh
  - Units that choose to participate in day-ahead pumped storage optimization program are considered not dispatchable in Day-Ahead market

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Resources Not Following Dispatch

Units assessed deviations as Real-time MWh – UDS LMP Desired MWh when…

- Unit's real-time economic minimum > Day-ahead Economic Minimum by 5% or 5 MW, whichever is greater **OR**
- Unit's real-time economic maximum < Day-ahead Economic Maximum by 5% or 5MW, whichever is lower AND UDS LMP Desired MW is either below real-time economic minimum or above real-time economic maximum, respectively

Resources Excluded from Deviation calculations

Hours during which generator is assigned by PJM for …

1. Regulation **OR**
2. Synchronized Reserve (and actual MWh are less than day-ahead scheduled MWh) **OR**
3. Non-Synchronized Reserve **AND**
4. Actual MWh < day-ahead scheduled MWh

Are omitted from deviation calculation

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Supplier Netting at Bus

- Generator injections at same bus are electrically equivalent as far as their impact on electric system
- Generators that deviate from real-time dispatch may offset deviations by another generator at same bus
- For deviations purposes, these two units look like one unit

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Generator Deviations

5-Minute Interval

1. Assess generator eligibility for deviations using current business rules
2. If eligible, calculate generator deviation MW
3. If generator deviation MW ratio is within 5%, no deviations calculated
4. Apply supplier netting for units located at “single bus”

Hour

1. Average of 5-minute generator deviation MW
2. If average generator deviation < 5 MWh, no deviations calculated

Day

1. Total Generator Hourly Deviations

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Operating Reserve Generator Deviation Example

5-Minute Interval End	DA Cleared (MW)	**OR Desired Gen (MW)**	**RT Profiled Gen (MW)**	Gen Deviation Eligibility	Gen Deviation Ratio	**RT Deviation (MW)**
:05	200	200	0	Yes	100%	200
:10	200	200	0	Yes	100%	200
:15	200	200	0	Yes	100%	200
:20	200	200	0	Yes	100%	200
:25	200	200	0	Yes	100%	200
:30	200	200	0	Yes	100%	200
:35	200	100	100	No	N/A	0
:40	200	98	100	Yes	2%	0
:45	200	40	100	Yes	150%	60
:50	200	150	100	Yes	33%	50
:55	200	200	100	Yes	50%	100
1:00	200	200	100	Yes	50%	100
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Hourly average of 5-minute intervals

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