Market Settlements - Advanced
Generation Operating Reserves Module
Agenda

• Generation
  – Segmented Make-Whole Payments
  – Deviations
  – Supplier Netting at the Bus
  – Real Time Values
Segmented Make-Whole Payments

Segmented Make-Whole Payments as a function of the greater of the DA Schedule, or Min Run Time

• A resource will be made whole for two periods for each synchronized start
  – The two periods are as follows:
    1. greater of the DA Schedule or Min Run time
    2. hours in excess of #1 (above)

• Segment does not “carry over” to the next day

• Start-up costs (and applicable no-load costs) will be in the segment “greater of the DA Schedule or Min Run Time”

• Segmented Make-Whole Payments are an overall benefit to resources
Example 1: Unit was extended in real time for two hours beyond its day ahead schedule (LMP is less than offer during extended period)

**Explanation:**

**Segment 1: Day Ahead Schedule**
- DA Energy = (4 hours * $100 * 150 MW) = $60,000
- DA Offer = (4 hours * $75 * 150 MW) = $45,000
- Day Ahead OR Credit: $0
- Balancing OR Credit: $0

**Segment 2: Extended Period**
- RT Energy = (2 hours * $50 * 150 MW) = $15,000
- RT Offer = (2 hours * $75 * 150 MW) = $22,500
- Balancing OR Credit: $7,500
Example 2: Unit was extended in real time through the midnight period, The unit was uneconomic for most of the extended period

Explanation:

Segment 1: Day Ahead Schedule
- DA Energy = (16 hours * $100 * 150 MW) = $240,000
- DA Offer = (16 hours * $75 * 150 MW) = $180,000
- DA OR Credit: $0
- Balancing OR Credit: $0

Segment 2: Extended Period
- RT Energy = (4 hours * $25 * 150MW) + (3 hours * $50 * 150MW) + (1 hour * $110 * 150 MW) = $54,000
- RT Offer = (8 hours * $75 * 150MW) = $90,000
- Balancing OR Credit: $36,000
Segmented Make-Whole Payments
Example 3 – Unit Y Extended Beyond Min Run Time

Example 3: Unit was extended in real time for four hours beyond its min run time (LMP is less than offer during extended period)

Explanation:

Segment 1: Min Run Time
- RT Energy = (4 hours * $80 * 150 MW) = $48,000
- RT Offer = (4 hours * $75 * 150 MW) = $45,000
- Balancing OR Credit: $0

Segment 2: Extended Period
- RT Energy = (4 hours * $50 * 150 MW) = $30,000
- RT Offer = (4 hours * $75 * 150 MW) = $45,000
- Balancing OR Credit: $15,000
**Segmented Make-Whole Payments**

**Example 4 – Unit Y Extended Beyond Min Run Time**

Example 4: Unit was extended in real time for four hours beyond its min run time (LMP is less than offer during extended period)

### Explanation:

#### Segment 1: Min Run Time

- RT Energy = (2 hours * $100 * 150 MW) + (2 hours * $25 * 150 MW) = $37,500
- RT Offer = (4 hours * $75 * 150 MW) = $45,000
- Balancing OR Credit: $7,500

#### Segment 2: Extended Period

- RT Energy = (2 hours * $75 * 150MW) + (2 hours * $100 * 150MW) = $52,500
- RT Offer = (4 hours * $75 * 150MW) = $45,000
- Balancing OR Credit: $0
Example 5: CT Unit had DA commitment and was called to run in RT. The DA commitment and the time when the unit was called to run do not align.

- **Segmented Make-Whole Payments**
- **Example 5 – CT Unit w/ DA Schedule is called in RT**

Even though the CT had a DA commitment, Segment 1 would be the 3 Hour Min Run Time (greater than the 1 Hour DA as shown)

Segment 2 would be for the hours extended past the Min Run Time
Example 6: CT Unit had DA commitment and was called to run in RT. The DA commitment and the time when the unit was called to run do not align.

- **DAY AHEAD AWARD**
- **CT Extended past**
- **Min Run Time**
- **MIN RUN TIME**

The first hour of the DA Award would not be considered for BOR calculations. Segment 1 would be the remaining 4 hours of the DA award (greater than the 3 hour Min Run Time).

- **Segment 1**: The Min Run Time would not apply for calculation of Segment 1.
- **Segment 2**: Would be for the hours extended past the DA Award.

CT Called to Run

Segment 1: 3 Hours

Segment 2: 4 Hours

DAY AHEAD AWARD

CT Extended past

Min Run Time

MIN RUN TIME

05/24/2017

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Agenda

- Generation
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  - Deviations
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  - Real Time Values
Create greater incentive for generators to follow PJM real-time dispatch instruction rather than day-ahead schedule

Determination of generation deviations will be made using the following criteria:

1. Ramp-Limited Desired MW
2. % Off Dispatch
3. MW Off Dispatch

Once a generator is deemed “deviating,” charges will be based on operational characteristics of the generator and of one of the following calculations:

1. Real Time MWh – Ramp Limited Desired MWh
2. Real Time MWh – UDS LMP Desired MWh
3. Real Time MWh – Day-Ahead MWh
Definitions and Acronyms

- **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 the hourly integrated SCED LMP to the unit’s bid curve to determine a corresponding MW value (this value is not ramp-limited)
- **Day-Ahead MWh** – the participants DA market position
- **% Off Dispatch** – percentage off dispatch using the lesser of the difference between the actual output and the UDS basepoint or the actual output and Ramp Limited Desired MW
- **MW Off Dispatch** – MW off dispatch using the lesser of the difference between the actual output and the UDS basepoint or the actual output and Ramp Limited Desired MW
- **% Off Dispatch & MW Off Dispatch** time-weight the values over the hour

Which units will this apply to?

- DA Scheduled units
- RA Run (2nd pass) Scheduled units
- Must-Run units that are dispatchable and dispatched above Eco Min
Operating Scenarios with Ramp Limited Desired MW

Operating scenarios of the generator will determine if and how a deviation is calculated.

- No Deviation Calculation?
- Real Time MWh – Ramp Limited Desired MWh?
- Real Time MWh – UDS LMP Desired MWh?
- Real Time MWh – Day-Ahead MWh?

See Operating Agreement for more details.
Pool-scheduled and dispatchable self-scheduled resources operating above economic minimum will then be considered to be following dispatch if:

1. its actual output is between its Ramp Limited Desired MW and UDS Basepoint,
2. % off dispatch is less than or equal to 10, or
3. hourly integrated Real-time MWh are within five percent (5%) or 5 MW (whichever is greater) of the hourly integrated Ramp-Limited Desired MW
Not Following Dispatch

Each **pool-scheduled** or **dispatchable self-scheduled** generator not following PJM dispatch due to:

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

Will be assessed deviations as Real-time MWh – ramp-limited desired MWh

*If the % off dispatch is > 20%, deviations will be assessed as Real-time MWh – UDS LMP Desired MWh
Not Following Dispatch

Resources will be assessed deviations as Real-time MWh – Day-ahead Schedule MWh for the following:

1. The self-scheduled generating resource has an economic maximum limit less than or equal to 110% of the economic minimum limit or

2. The resource was not dispatched by PJM above its economic minimum, unless it is lowering its output in accordance with PJM direction in response to a minimum generation emergency event (or declaration)
Not Following Dispatch

• Each unit that has a Day-ahead schedule and tripped or is scheduled Day-Ahead and does not run in Real-time will be assessed deviations as Real-time MWh – Day-Ahead scheduled MWh
Not Dispatchable

• Each unit that is dispatchable Day-Ahead but is Fixed Gen in real-time will be assessed deviations as Real-time MWh – UDS LMP Desired MWh

• Each unit that is not dispatchable in both the Day-ahead and Real-time market will be assessed deviations as Real-time MWh – Day-ahead scheduled MWh.

• Units that choose to participate in the Day-ahead pumped storage optimization program are considered not dispatchable in the Day-Ahead market
Units will be assessed deviations as Real-time MWh – UDS LMP Desired MWh when:

1. The unit’s real-time economic minimum is greater than its Day-ahead economic minimum by 5% or 5 MW, whichever is greater, or

2. The unit’s real-time economic maximum is less than its Day-ahead economic maximum by 5% or 5 MW, whichever is lower, and

3. UDS LMP Desired MWh for the hours is either below the real-time economic minimum or above the real-time economic maximum, respectively
Excluded from Deviation calculations

Hours during which a generator is assigned by PJM for:
1. Regulation,
2. Synchronized Reserve (and actual MWh are less than day-ahead scheduled MWh), or
3. Non-Synchronized Reserve (and actual MWh are less than the day-ahead scheduled MWh) are omitted from deviation calculation
• Generation
  – Segmented Make-Whole Payments
  – Deviations
  – Supplier Netting at the Bus
  – Real Time Values
Supplier Netting at the Bus

• Recognize that generator injections at the same bus are electrically equivalent as far as their impact on the system

• Generators that deviate from RT dispatch may offset deviations by another generator at the same bus

• For deviations purposes, these two units will look like one unit
Supplier Netting at the Bus

Generators A and B are located at the same bus. Both generators are deemed to be “not following dispatch” for a given hour.

<table>
<thead>
<tr>
<th>RT Desired MW</th>
<th>Station A 138KV ST1</th>
<th>Station A 138KV ST2</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RT Output (MW)</th>
<th>112</th>
<th>178</th>
</tr>
</thead>
</table>

| Deviation (MW) | 12  | -22 |

Deviation MW at the Bus:
12MW + (-22MW) = 10MW  

(**5% or 5 MW of Desired is calculated at the individual generator level prior to netting the two deviations. Therefore, both units are considered deviating)

Total MWs subject to BOR charges: 10MW

** Note: Ramp Limited Desired MW calculation could also be applicable.
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  – Real Time Values
Real Time Values

Market Sellers have the ability to communicate actual operational parameters to PJM before and after the day-ahead market closes using the ‘Real-time Value’ functions in Markets Gateway.

Real-time Values should be utilized when a resource cannot operate according to the unit specific parameters (Capacity Performance and Base Capacity resources), default Parameter Limit Schedule (non-Capacity Performance resources), or pre-approved parameter exceptions (all capacity resources).
Real Time Values

• Real-time values are used in the calculation of Operating Reserve make-whole credits except in cases where unit-specific parameters apply.
  – Effective 6/1/2016, unit-specific parameters apply to the cost-based schedules and price-based parameter limited schedules of Generation Capacity Performance Resources.
  – Effective 6/1/2018, unit-specific parameters also apply to the cost-based schedules and price-based parameter limited schedules of Generation Base Capacity Resources.

• Unit-specific parameters do not apply to price-based (non-PLS) schedules.
Real Time Values

• The Real Time Values consist of the following values:
  – Turn Down Ratio
  – Minimum Down Time
  – Minimum Run Time
  – Maximum Run Time
  – Start Up Time
  – Notification Time
Real Time Values and Operating Reserve Credits

• If a Capacity Performance or Base Capacity generator is committed or running on its cost-based or price-based parameter limited schedule, the generator **will not** be made-whole for hours in which the real-time values are less flexible than the unit-specific parameters.

• Positive net revenues (revenues > offer) for the less flexible hours will be used in the Operating Reserve credit calculation.

• Additionally, the unit will not be eligible for Operating Reserve Lost Opportunity Cost Credits for the applicable hours.
Real Time Values and Operating Reserve Credits

A Generation Capacity Resource that operates outside of its unit-specific parameters will not receive Operating Reserve Credits nor be made whole for such operation when not dispatched by the Office of the Interconnection, unless the Market Seller of the Generation Capacity Resource can justify to the Office of the Interconnection that operation outside of such unit – specific parameters was the result of an actual constraint. Such Market Seller shall provide to the Market Monitoring Unit and the Office of the Interconnection its request to receive Operating Reserve Credits and/or to be made whole for such operation, along with documentation explaining in detail the reasons for operating its resource outside of its unit-specific parameters, within thirty calendar days following the issuance of billing statement for the Operating Day.
## Affects of Less Flexible Parameters

<table>
<thead>
<tr>
<th>Real-Time Value Parameter</th>
<th>(Hourly Positive Net Revenue)</th>
<th>Lost Opportunity Cost Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn Down Ratio</td>
<td>Any hour that the unit violates the Turn Down Ratio and has negative net revenue, the hourly net revenue is set to 0.</td>
<td>The unit is ineligible for LOC for all hours that the unit violates the Turn Down Ratio.</td>
</tr>
<tr>
<td>Min Down Time</td>
<td>If a unit extends its Min Down Time, and PJM keeps the unit on because it can't be cycled, any hour in the extended hours as logged by PJM that the unit has negative net revenue, the hourly net revenue is set to 0.</td>
<td>The unit is ineligible for LOC for the extended hours that the unit remains on as logged by PJM.</td>
</tr>
<tr>
<td>Min Run Time</td>
<td>If a unit extends its Min Run Time, any hour in the extended hours that the unit has negative net revenue, the hourly net revenue is set to 0.</td>
<td>A unit is ineligible for LOC in all hours of extended Min Run Time</td>
</tr>
<tr>
<td>Max Daily Starts</td>
<td>If a unit reduces its Max Daily Starts, and PJM keeps the unit on because it can't be cycled, any hour in the extended hours as logged by PJM that the unit has negative net revenue, the hourly net revenue is set to 0.</td>
<td>The unit is ineligible for LOC for the extended hours that the unit remains on as logged by PJM.</td>
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## Affects of Less Flexible Parameters

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<td>Max Weekly Starts</td>
<td>If a unit reduces its Max Weekly Starts, and PJM keeps the unit on because it can't be cycled, any hour in the extended hours as logged by PJM that the unit has negative net revenue, the hourly net revenue is set to 0.</td>
<td>The unit is ineligible for LOC for the extended hours that the unit remains on as logged by PJM.</td>
</tr>
<tr>
<td>Max Run Time</td>
<td>No impact</td>
<td>No impact</td>
</tr>
<tr>
<td>Start-up Time</td>
<td>If a unit extends its Start-up Time and PJM keeps the unit on because it can't be cycled, any hour in the extended hours as logged by PJM that the unit has negative net revenue, the hourly net revenue is set to 0.</td>
<td>Whether online or offline, the unit is not eligible for LOC for the extended hours beyond the unit specific parameter.</td>
</tr>
<tr>
<td>Notification Time</td>
<td>If a unit extends its Notification Time and PJM keeps the unit on because it can't be cycled, any hour in the extended hours as logged by PJM that the unit has negative net revenue, the hourly net revenue is set to 0.</td>
<td>Whether online or offline, the unit is not eligible for LOC for the extended hours beyond the unit specific parameter.</td>
</tr>
</tbody>
</table>
Settlement Example

• Unit Specific Min Run Time – 4 hours
• Real-Time Value Min Run Time – 7 hours
• Day-ahead Operating Reserves
• Dollar amounts represent hourly net revenue
  – Positive value = Revenue > Offer
  – Negative value = Offer > Revenue
Hours during the Extended Real-Time Value Min Run Time with hourly positive net revenue are considered as additional revenue. HE 10 and HE 11 have negative net revenue and are set to $0.

- DA Net Revenue (Unit Specific Min Run Time) is -$75. Eligible for $75 in DA Op Res Credits.
- Additional DA Revenue (Extended Min Run Time) is $85.
- In this case, Additional DA Revenue (Extended Min Run Time) >= DA Op Res Credit, so generating resource receives $0 in DA Op Res Credits.
Questions?

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The Member Community is PJM’s self-service portal for members to search for answers to their questions or to track and/or open cases with Client Management & Services