PJM Regulation Market
Objectives

Students will be able to:

• Identify the process and procedures for participating in the Real-Time Regulation Market
What is Regulation?

Regulation is:
- A variable amount of generation energy under automatic control
- Independent of economic cost signal
- Obtainable within five minutes
- Responds to frequency deviations

• These generating units or demand response resources provide fine tuning that is necessary for effective system control

• Regulating units correct for small load changes that cause the power system to operate out of balance (measured as “ACE”)
Real-Time Regulation Data/Terms

PJM >> Member

AReg – Assigned Regulation
• Static for hour as a result of market
• Sent by PJM for each resource capable of regulation

RegA – Regulation Control Signal
• Automated Generator Control signal sent by PJM to Resource owner
• Sent every 2 seconds
• Bounded by TReg

RegD – Fast Regulation
• Automated Generator Control signal sent by PJM to Resource owner
• Dynamic signal moves with the frequency deviation component of ACE
• Increases the “utilization” of the energy storage devices

Member >> PJM

TReg – Total Regulation
• Resource owner sends one number for the fleet regulation capability

CReg – Current Regulation
• Calculated value where fleet is operating relative to regulation band
• Fleet-wide value sent from Resource owner to PJM
• Sent every 4 seconds

Unit Reg – Resource allocation
• Allocation should be sent as percent allocation for each individual regulating resource of the resource AReg

Load BP – Operational Midpoint
• The point around which the regulating resource (unit, plant or registration) operates
Band of Regulation for Generator

- Economic Maximum
- Economic Minimum
- Economic Basepoint
- MW Regulation Capability
- Offered into Markets Gateway

High Regulation Limit

Basepoint + Capability

Low Regulation Limit

Basepoint + Capability

If high and low regulation limits are not most restrictive, then ASO uses most restrictive min and max*

* Band of regulation must fall within the economic limits of the generating unit
Regulation in Real-Time Operations

PJM generates AR signal (derived from ACE) for the RTO

Generator

Reg A/D - % of total AR signal

Market Operation Center

% of MOC RegA/D signal

Reg Unit

Reg Unit

Reg Unit

TReg - Total MW on regulation

TReg - Total MW on regulation

PJM generates AR signal (derived from ACE) for the RTO

Generator

Reg A/D - % of total AR signal

Market Operation Center

% of MOC RegA/D signal

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PJM generates AR signal (derived from ACE) for the RTO

Generator

Reg A/D - % of total AR signal

Market Operation Center

% of MOC RegA/D signal

Reg Unit

Reg Unit

Reg Unit

TReg - Total MW on regulation

TReg - Total MW on regulation
Regulation Offer Parameters

- **Reg Type** – The regulation type (Reg A or Reg D). For a unit with both Reg A and Reg D offers, two rows will display

- **Offer MW** – The amount of regulation MW offered for the unit
  - This field is required if the unit is either Available or Self-Scheduled to provide regulation

- **Price Offer** – Cannot be more than $100/MW total
  - **Capability Offer Price** – resource owner’s price to reserve MWs for regulation in $/MW
  - **Performance Offer Price** – $/MW price to provide regulation movement
    - Converted to $/ΔMW by multiplying the value by the ratio of ΔMW/MW for the applicable signal for that offer
Regulation Offers

- **Cost Offer** – Must Meet Manual 15 Guidelines

  - **Capability Offer Cost**: Cost to reserve MW in $/MW
    - Must be \( \leq (\text{fuel cost increase and unit specific heat rate degradation due to operating at lower loads}) + 12/\text{MWh} \)

  - **Performance Offer Cost**: $/MW cost increase due to Heat Rate Increase during non-steady state operation and Cost Increase in VOM
    - Converted to $/\Delta\text{MW} by multiplying the value by the ratio of $\Delta\text{MW}/\text{MW}$ for the applicable signal for that offer
Regulation Offers

• **Heat Rate @ Eco Max [BTU/kWh]** - The heat rate at the default economic maximum for a resource
  – The economic maximum that will correspond to this rate value will be the default economic maximum that is shown on both the Daily Regulation Offers and Unit Details pages
  – This is an optional parameter that may be submitted in the Markets Gateway System to support the cost-based regulation offer price

• **Heat Rate @ Reg Min [BTU/kWh]** - The heat rate at the default regulation minimum for a resource
  – The regulation minimum that will correspond to this rate value will be the default regulation minimum that is shown on both the Daily Regulation Offers and Unit Details pages
  – This is an optional parameter that may be submitted in the Markets Gateway System to support the cost-based regulation offer price
Regulation Offers

• **VOM Rate [$/MWh of Regulation]** - The increase in VOM resulting from operating the regulating resource at a higher heat rate than is otherwise economic for the purpose of providing regulation

• **Fuel Cost [$/MBTU]** - The fixed fuel costs of the resource
  – This value will be used to determine the heat rate adjustments during steady-state and non steady-state operation for the purpose of providing regulation
  – This is an optional parameter that may be submitted in the Markets Gateway System to support the cost-based regulation offer price

• **Energy Storage Loss [$/MWh of Regulation]** - The value is used to account for the energy losses experienced by an energy storage device while providing regulation service
  – This field is valid only for energy storage resources
Regulation Offers

- **Eco Max MW** - Maximum generation limit when unit is providing regulation. This value is entered on the Unit Detail page and can only be edited there.

- **Reg. Min MW** - Minimum generation limit when unit is providing regulation. This value is entered on the Unit Detail page and can only be edited there.

- **Min Offer MW** - Minimum MW for assignment. The value should not be greater than the Offer MW.

- **Available Status** - availability of unit
  - Available
  - Not Available

- **Self Scheduled** - indication the resource is self scheduled.

- **Rolling Avg. Performance Score** - The average performance score for the last 100 operating hours. It is used to adjust the capability and performance offer.
Regulation Market Clearing Process

- PJM’s Market Clearing Engine (MCE) jointly optimizes energy, regulation, synchronized reserves, and non-synchronized reserves products
- Goal of optimization is to minimize total cost of producing energy, regulation, and reserves
- Resources cannot be committed for more than one of non-synchronized reserve, synchronized reserve, or regulation products during same interval
Regulation Market Time Line

Resources that are opted in to intraday offers may submit Synchronized Reserve offers up to 65 minutes before the operating hour.

Throughout the Operating Day

PJM Clears the Regulation Market Hourly and Periodically Tests Performance

Regulation Offers (Cost & Price) due by 14:15 EPT for next operating day

2:15 pm
Morning
Evening
Regulation Market Timing

60 minutes before:
- ASO calculates Regulation Commitments

30 minutes before:
- Regulation Commitments posted

Operating Hour:
- LPC Calculates 5 min RMCPs
# Regulation Market Results

<table>
<thead>
<tr>
<th>What</th>
<th>Frequency</th>
<th>Location</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment</td>
<td>Hourly</td>
<td>Markets Gateway</td>
<td>30 min prior to top of hour</td>
</tr>
<tr>
<td>Clearing Price</td>
<td>Every 5 minutes</td>
<td>Data Viewer</td>
<td>Every 5 min</td>
</tr>
</tbody>
</table>

Public results in Markets Gateway under:
Public >> Market Results A/S >> Regulation Results

Private Generator Results under:
Generator >> Market Results >> Regulation and Reserve Award
Managing Regulation Data

The following Markets Gateway pages are used to manage the Regulation Offers:

- **Unit Detail** - use this web page to enter regulating high and low limits

- **Regulation Offer** - use this web page to create regulation offers and modify the status of the regulation offer

- **Regulation Updates** - use this web page to update regulation resource availability and parameters on an hourly basis

- **Regulation A/D Updates** - use these web pages to make intra-day updates to regulation MW’s, availability, and offer prices and costs

- **Regulation Bilateral Transactions** - use this web page to facilitate a regulation bilateral transaction
Regulation Parameters in Unit Detail

• **Regulation Max MW**: Maximum generation limit when unit is providing regulation

• **Regulation Min MW**: Minimum generation limit when unit is providing regulation

• **Reduced Ramp Rate (%) = Minimum Reduced Ramp Rate Floor Percent** - Minimum percentage of the bid-in ramp rate used for the reduced energy ramp rate logic when a unit is providing both energy and regulation
  
  • If zero (the default value), then 100% of the assigned Regulation MW (divided by 5) will reduce the bid-in energy ramp rate for SCED
  
  • Note: Hourly updates are made on the Regulation Update Screen, not the Unit Hourly Screen
Markets Gateway

Markets Gateway is a PJM tool that allows members to submit information and obtain data needed to conduct business in the Day-Ahead, Regulation and Synchronized Reserve Markets.

Production: Sign In | Register

Sandbox: Sign In | Register

Date


Tutorial: Copy/Paste or Entering Data  PDF  2.2.2016
October 2015 Sandbox Demonstration: Presentation  WEB | PDF  10.29.2015
August 2015 Sandbox Demonstration: Presentation  WEB | PDF  8.31.2015

Markets Gateway Documentation

# Markets Gateway Materials

## XML Information

Browserless cookie/token timeout information:

- The cookie/token is good for 8 hours.
- The cookie/token is invalidated after 30 minutes of inactivity.

<table>
<thead>
<tr>
<th>Document</th>
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<tbody>
<tr>
<td>Browserless: Basic Instructions and Sample C# Code <strong>PDF</strong></td>
<td>3.16.2016</td>
</tr>
<tr>
<td>Production WSDL <strong>DOC</strong></td>
<td>2.17.2016</td>
</tr>
<tr>
<td>Gas Unit Commitment Coordination <strong>PDF</strong></td>
<td>1.19.2016</td>
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<tr>
<td>Browserless: Sample VBA Code <strong>XLS</strong></td>
<td>12.8.2015</td>
</tr>
<tr>
<td>External Interface Specification Guide - Revision 45 <strong>PDF</strong></td>
<td>10.15.2015</td>
</tr>
<tr>
<td>XML Schema <strong>XSD</strong></td>
<td>5.6.2015</td>
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## Markets Gateway Documentation

Questions?

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Website:  www.pjm.com

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.