PJM Reserve Market
Objectives

Students will be able to:

• Identify the process and procedures for participating in the Real-Time Reserve Market
Reserves Overview

What are Reserves?

- Reserves are additional generation capacity above the expected load
  - Protects the power system against the uncertain occurrence of future operating events:
    - Loss of generation or load forecasting errors

<table>
<thead>
<tr>
<th>Reserves Type</th>
<th>Time Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day Ahead Scheduling Reserve</td>
<td>( T \leq 30 \text{ min.} )</td>
</tr>
<tr>
<td>Primary Reserve</td>
<td>( T \leq 10 \text{ min.} )</td>
</tr>
<tr>
<td>Synch Reserves (Synchronized)</td>
<td></td>
</tr>
<tr>
<td>Non-Synch Reserves (Off-line)</td>
<td></td>
</tr>
<tr>
<td>Secondary Reserves</td>
<td>( 10 \text{ min.} \leq T \leq 30 \text{ min.} )</td>
</tr>
</tbody>
</table>
Reserve Markets

Reserve Services
Each service carries a reserve requirement

Primary Reserve

Synchronized Reserve

Non-Synchronized Reserve (NSR)

Tier 1 resources

Tier 2 resources

Flexible

Inflexible

Reserve Products
Each product has a clearing price

PJM Operates in real-time to ensure Contingency/Primary (10 minute) and Synchronized Reserve Requirements are always maintained
Synchronized Reserves

Tier 1 Resources

- Online units that follow economic dispatch and only partially loaded
  - Able to increase output within 10 minutes following PJM dispatcher request to an event

Tier 2 Resources

- Resources that offered into the Synchronized Reserve Market
  - Cleared Condensers (CTs & hydro) transition to online Tier 2 condense mode
- Steam reduced to provide Tier 2 CTs online at min – operating at a point that deviates from economic dispatch
  Demand Response that can drop load
Tier 2 Requirements

• Eligibility
  – “Generation Resources and Demand Resources must be able to provide 0.1 MW of Tier 2 Synchronized Reserve Capability in order to participate in the Tier 2 Synchronized Reserve Market.” (Manual 11 – Section 4.2.1)

• Commitment
  – “Any resource that is committed for Tier 2 when a synchronizes event occurs is obligated to respond for their commitment at the start of the event within 10 minutes” (Manual 11 – Section 4.2.7)
Call for Synchronized Reserve

Loading of Synchronized Reserve is a Reliability Service!

- The resource owners implement the requested percentage of Synchronized Reserve:
  - Without regard to price and as quickly as possible
- Continue to implement Synchronized Reserve until directed by PJM dispatcher to discontinue
  
  At most, one level of operator intervention between PJM and customer reducing load
Synchronized Reserve Offers

- **Offer MW** - The amount of Synchronized Reserve MW offered for the unit
  - The Synchronized Reserve quantity is defined as the increase in output achievable by the unit in ten (10) minutes

- **Offer Price** - Must be a positive number; required if the unit is available for Synchronized Reserve
  - A Synchronized Reserve offer price may not exceed the unit’s O & M cost (as determined by the Cost Development Subcommittee) plus $7.50/MWh margin

- **Condense Energy Use** - This is the amount of energy a condensing unit consumes in an hour while operating in the condensing mode

- **Condense Startup Cost** - This is the actual cost associated with getting a unit from a completely off-line state into the condensing mode including fuel, O&M, etc.
Managing Synchronized Reserve Data

- **Condense to Gen Cost** - The cost, in dollars, of transitioning a condenser to the generating mode. The value submitted for this cost must be less than or equal to the condense Startup cost.

- **Full Load Heat Rate** - The heat rate of the unit, specified in BTU/kWh, when the unit is at full load.

- **Reduced Load Heat Rate** - The heat rate of the unit, specified in BTU/kWh, when the unit is at reduced load.

- **VOM Rate** - The variable rate, in dollars, of operating and maintenance costs.
Managing Synchronized Reserve Data

- **Spin as Condenser** - Used to identify if a combustion turbine can be committed for synchronized reserve as a condenser.

- **Condenser Available Status** - Status of the resource availability for condensing.
  - *Available* - Indicates if the unit is available to condense for voltage support.
  - *Not Available* - Indicates if the unit is unavailable to condense for voltage support.
## Synchronized Reserve Market Timeline

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 a.m.</td>
<td>Due a day ahead of the operating day, by 10:30 a.m.</td>
</tr>
<tr>
<td></td>
<td>- Energy schedule for LOC calculation to qualified units</td>
</tr>
<tr>
<td>2:15 p.m.</td>
<td>Due a day ahead, by 2:15 p.m. Tier 2 Offer Price (capped at actual cost + $7.50/MWh adder)</td>
</tr>
<tr>
<td></td>
<td>- All other SR data can be revised up to 65 minutes before the operating hour.</td>
</tr>
<tr>
<td>6:30 p.m.</td>
<td>Up to 65 min prior to the operating hour</td>
</tr>
<tr>
<td></td>
<td>- SR status (Available, Unavailable)</td>
</tr>
<tr>
<td></td>
<td>- Offer MW</td>
</tr>
<tr>
<td></td>
<td>- Offer Price*</td>
</tr>
<tr>
<td></td>
<td>- Self-Scheduled MW</td>
</tr>
<tr>
<td></td>
<td>- Spin Max</td>
</tr>
<tr>
<td></td>
<td>*subject to intraday offer rules</td>
</tr>
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</table>

Data submitted to Markets Gateway
Synchronized Reserve Timing

- A forward commitment for some reserve resources and all regulation resources will be posted 30 minutes prior to the operating hour
  - Synchronous Condensers and Demand Response resources will be considered “inflexible” units and committed on a forward basis

60 minutes before

- ASO* calculates inflexible resource Tier 2 commitments and preliminary Tier 1 estimate

30 minutes before

- Inflexible Tier 2 commitments and preliminary Tier 1 estimate posted

RT SCED calculates 5 min available Tier 1 and Tier 2 assignments; LPC calculates SRMCPs

Incremental commitments may be made for inflexible units

*Ancillary Service Optimizer
<table>
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<th>What</th>
<th>Frequency</th>
<th>Location</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Tier 1 Estimate</td>
<td>Hourly</td>
<td>Markets Gateway</td>
<td>30 min prior to top of hour</td>
</tr>
<tr>
<td>Inflexible Tier 2 Assignment</td>
<td>Hourly</td>
<td>Markets Gateway</td>
<td>30 min prior to top of hour</td>
</tr>
<tr>
<td>Flexible Tier 2 Assignment</td>
<td>Every 5 minutes</td>
<td>ICCP link</td>
<td>Every 5 min</td>
</tr>
<tr>
<td>Clearing Price</td>
<td>Every 5 min</td>
<td>Data Viewer</td>
<td>Every 5 min</td>
</tr>
</tbody>
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Non-Synchronized Reserve Timing

Operating Hour

60 minutes before:
ASO calculates hourly NSR estimates

30 minutes before:
NSR estimates posted

RT SCED calculates 5 min assignments; LPC calculates NSRMCPs
## Non-Synchronized Reserve Results Posting

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Must Offer Requirement

• A must offer requirement is applied to the Synch Reserve and Non-Synchronized Reserve Markets

• Implicit must offer requirements are already built into the design of Tier 1 Synch Reserve and NSR
  – All online generation resources following PJM’s dispatch and operating below eco max are automatically considered in the commitment of Tier 1 resources
  – All available offline generation capable of providing energy within 10 minutes are automatically considered in the commitment of NSR
Must Offer Requirement

• Must offer requirement for Tier 2 Synch Reserve resources
  – All non-emergency capacity resources available to provide energy and capable of providing synchronized reserves must submit offers for Tier 2 Synchronized Reserves
    • Applies only during periods for which PJM has issued a Primary Reserve Warning, Voltage Reduction Warning or Manual Load Dump Warning
  – Penalty for violating the must offer requirement is referral to the Market Monitor, similar to the day-ahead must offer requirement for capacity generation resources
Non-Synchronized Reserve Offers

• The Non-Synchronized Reserve Market is a cost-based market

• Being off-line and available within 10-minutes as a part of economic dispatch does not entail a cost, therefore:
  – No explicit offer is entered in Markets Gateway
    • All eligible resources will be considered to have an offer of $0/MWh
    • The NSR MW available from each resource will be calculated based on:
      ▪ Startup and Notification Time from lesser of cost schedule and price schedule
      ▪ Economic Minimum
      ▪ Synch Reserve Ramp Rate, or energy ramp rate in absence of a synch reserve ramp rate

• No Three Pivotal Supplier test - already a cost-based market
Managing Synchronized Reserve Data

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

- **Unit Detail** - use this web page to enter Synchronized Reserve maximum limit for Tier 1 resources

- **Synchronized Reserve Offers** - use this web page to create Synchronized Reserve offers for Tier 2 resources and modify the status of the Synchronized Reserve offer

- **Synchronized Reserve Updates** - use this web page to modify synchronized reserve resource availability, prices and parameters on an hourly basis (up to 65 minutes before the top of the hour)

- **Synchronized Reserve Bilaterals** - use this web page to facilitate a Synchronized Reserve bilateral transaction
Questions?

PJM Client Management & Services
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Toll Free Telephone:  (866) 400-8980
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