Day-Ahead Energy Market
Objectives

Students will be able to:

• Identify the process and procedures for participating in the Day-Ahead Market
Markets Gateway Intro
PJM Markets Gateway is the system that PJM Market Participants use to participate in the Day-Ahead Energy Market, Synchronized Reserve Market, and Regulation Market. Market Participants can use PJM Markets Gateway to prepare and submit:

- Generation offers
- Regulation offers
- Synchronized reserve offers
- Demand bids
- Increment offers and decrement bids
- Load response bids
Uses of Markets Gateway

- Enter bilateral regulation and reserve transactions
- Review public and private Day-Ahead Energy and Ancillary Services market results
Interfacing with Markets Gateway

• **Web-based Interactions** — access is provided through a series of web-based interactive displays, which are accessible through the internet

• **XML-formatted File Exchange** — input and output files that are posted or downloaded, using the market user interface (MUI) or another participant-created application
PJM Day-Ahead Market
Capacity Resource Requirements

• Any generator that is a PJM generation capacity resource that has an RPM Resource Commitment:
  – Must submit an offer schedule into the Day-ahead Market even if it is self-scheduled or unavailable due to outage

• Generation capacity resources shall submit:
  – A schedule of availability for the next seven days
  – May submit non-binding offer prices for the days beyond the next Operating Day

• The set of offer data last submitted for each generation capacity resource
  – Shall remain in effect for each day until specifically superseded by subsequent offers
# PJM Markets Timeline

<table>
<thead>
<tr>
<th>0800-1030</th>
<th>1030-1330</th>
<th>1330-1415</th>
<th>1415-2400</th>
</tr>
</thead>
</table>

**Ops. Technical Analysis**
- 0800 - 1030

**Market Participant Bid/Offer Period**
- Before 1030
- Market participants enter bids and offers.

**Day - Ahead Results Posted & Balancing**
- 1030 - 1330
- Process all the markets requests from day-ahead bids
- Post Day-Ahead Market results by 1330

**Re-bid Period**
- After day-ahead results are available -1415
- Make adjustments based on the clearing results.

**Balancing Market Bid Period Closes**
- 1415 - Midnight

**Commitments**
- Second
  - Reliability analysis includes:
    - Updated offers
    - Unit availabilities
    - PJM load forecast info

**Supplemental**
- Reliability performed as needed
- Minimize start-up and cost to run

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Unit Parameters
Unit Parameters

• Each generator has different characteristics that it submits to PJM along with their energy offer

• These variables can be cost-based, price-based, time-based, or physical parameters
Generators can be cost-based or price-based:

- Determined for each new unit or new unit ownership

  - Cost (per cost development guidelines)
  
  - Price (per participants offer strategy)
  
  - A generation capacity resource offer may not exceed $2000/MWh
Energy Market Offer Cap: Cost-Based Offers

- For the purposes of setting LMP, all offers are capped at $2,000/MWh
  - Cost-based offers above $2000/MWh will not be eligible to set LMP

- Generation resources with demonstrated costs above $2,000/MWh can recover those costs through make-whole payments
  - The 10% adder will not apply to costs above $2,000/MWh

- Participants wishing to enter cost-based offers above $2,000/MWh will need to contact the Markets Hotline to get assistance to enter such offers
  - Cost-based offers above $2,000/MWh will be considered in merit order for dispatch purposes
Energy Market Offer Cap: Price-Based Offers

- Price-based offers will be capped at the lower of $2,000/MWh or the corresponding cost-based offer when costs are above $1,000/MWh
  - Remain capped at $1,000/MWh when the corresponding cost-based offers are at or below $1,000/MWh

Example:
- If a unit’s cost offer is $1500, the price offer can be no higher than $1500
- If a unit’s cost offer is $800, the price offer can be no higher than $1000
- If a unit’s cost offer is $2200, the price offer can be no higher than $2000
Shortage Pricing

• Max energy price = energy offer cap + 2 * Reserve penalty factor
  – Yields $3,700/MWh max energy price under shortage conditions going forward

• Current offer cap rules apply year round
Notification and Startup Times

The following information can be changed on the Schedule Detail page:

Notification Times:
The time interval in hours, between PJM notification and the start sequence of a generating unit that is currently in one of three temperature states

- Hot Notification Time
- Inter Notification Time
- Cold Notification Time

Startup Times:
The time interval, measured in hours, from the actual unit start sequence to the breaker close for a generating unit in one of the three temperature states

- Hot Startup Time
- Inter Startup Time
- Cold Startup Time
Start Costs for Price-Based Units

1. Price-based units choosing price-based start-up and no-load costs can only change them twice per year effective for two six month periods
   - Entered on Unit Detail page

2. Price-based units have the option to submit cost-based start-up and no-load costs on a daily basis
   - Entered on Schedule Detail page
   - Must stay as cost-based start-up and no-load costs for the entire 6-month period
   - Choice between using cost-based or price-based start up and no-load fees can be made twice a year
### Bi-annual Periods for *Price Based* Start Costs

<table>
<thead>
<tr>
<th>Period</th>
<th>Period Covers:</th>
<th>Submit By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>April 1&lt;sup&gt;st&lt;/sup&gt; to September 30th</td>
<td>10:30 Hours March 31st</td>
</tr>
<tr>
<td>2</td>
<td>October 1&lt;sup&gt;st&lt;/sup&gt; to March 31st</td>
<td>10:30 Hours September 30th</td>
</tr>
</tbody>
</table>

If a priced based unit chooses the price-based start-up and no-load fees option, the decision cannot be changed until the next open enrollment period takes place.
Use Start Costs

• The generation owner determines whether PJM should use the startup and no load information for their unit (price-based or cost-based) on a daily basis

• This is accomplished by marking the Use Startup No Load switch available and unavailable on the Schedule Detail web page
Markets Gateway

Unit Parameters
# Unit Parameters in Markets Gateway

## Unit
- Unit Status
- Resource Type
- MW Operating Limits
- Ramp Rates
- Weather and Wind Forecasts
- Startup & No-Load Costs for **price-based units**

## Schedule
- Schedule Types and Selection
- Offer Curves
- MW Operating Limits
- Startup & No-Load Cost for **cost-based schedules**
- Startup/No-Load switch
- Startup and Notification times
- Min and Max Data
- Condenser Data

## Hourly Updates
- Commit Status
- MW Operating Limits
- Notification Time
Unit Detail

Unit default values are entered on the page

- **Emergency Max (MW)** - The MW energy level at which the operating company operates the generating unit once PJM requests Maximum Emergency Generation
  - This represents the highest short-term MW level a generating unit can produce and may require extraordinary procedures to produce the desired output

- **Economic Max (MW)** - The highest unrestricted level of energy, in MW, that the operating company operates the unit
  - This represents the highest output available from the unit for economic dispatch
**Unit Detail**

- **Economic Min (MW)** - The minimum energy available from the unit for economic dispatch

- **Emergency Min (MW)** - The lowest level of energy in MW the unit can produce and maintain a stable level of operation. The Operating Company operates the unit at this level during a Minimum Generation Emergency

- **CIR** - Indicates the MW value of the Capacity Interconnection Rights of the wind resource
  - For a wind resource, the Economic Min and Emergency Min must be less than or equal to the resource’s CIR value
**Unit Detail**

- **Default Ramp Rate (MW/Min)** – The default energy ramp rate, in MW/minute, for increasing or decreasing a unit’s output
  - This average rate is used by PJM in the Day-Ahead commitment process

- Use the **Unit Detail** web page to change the Startup and no-load costs during the open enrollment periods
  - Period 1 Cost Based Startup Cost and Period 2 Cost Based Startup Cost
    - Indicates whether or not a unit’s startup and no-load are cost based for Period 1 and Period 2 respectively
The MW segment ramp rates are used during real-time operations

- A maximum of 10 Ramp Rate segments can be defined

- The first MW/ramp rate segment represents the ramp rate from 0 MW/0 Min to the first MW/Min point

- The second MW/ramp rate point represents the ramp rate from the first MW point to the second MW point (and so on)
Synchronized Reserve Ramp Rates

• Synchronized reserve ramp rates may be specified for Tier 1 resources (MW/min)

• A maximum of 10 ramp rate segments can be defined

• These rates must be greater than or equal to the real time economic ramp rate(s) submitted for the unit
  – Synchronized ramp rates that exceed economic ramp rates must be justified via submission of actual data from past synchronized events to the PJM Performance Compliance Department
Schedule Parameters
Price-Based Unit Schedule Requirements

Units must have at least one cost-based schedule and at least one price-based schedules available:

1. Cost-based schedule must be parameter limited

2. Two price-based schedules
   a) Non-parameter limited
   b) Parameter limited - (Required)
Schedules define the offer and offer type

• Multiple schedules can be created
  – Schedule Name (8 characters) – Name used to reference schedule offer
  – Schedule Description (40 characters) – Text description of the schedule
  – Schedule Type
    • 1 - 69 and 80 - 90 — cost-based parameter limited schedules (PLS)
    • 70 - 79 — Price PLS schedules
    • 91 - 99 — price-based schedules

* Editing, Adding or Deleting is not permitted when market is closed
**Market Type**

- **DayAhead** - Indicates whether the schedule is available for the day-ahead market
- **Balancing** - Indicates whether or not the schedule is available for the balancing market (used for re-bidding period)
- **Both** - Indicates whether or not the schedule is available for both the day-ahead market and balancing market (used for re-bidding period)
- **Use Startup No Load** - The generation owner determines whether PJM should use the startup and no load information for their unit (price-based or cost-based) on a daily basis
Schedule Detail

• Minimum Downtime (hour) — The minimum number of hours between when the unit shuts-down and the next time the unit is put online

• Minimum Runtime (hour) — The minimum number of hours a unit must run

• Maximum Weekly Starts — The maximum number of times a unit can be started in one week

• Maximum Runtime (hour) — The max number of hours a unit can run before it needs to be shut down

• Maximum Daily Starts — The maximum number of times that a unit can be started in a day

• Maximum Weekly Energy (MWh) — The maximum amount of energy, reported in MWh, that the unit can produce in one week used for study purposes
Schedule Offers

• Up to 10 pairs of MW and pricing points can be created or modified for each price schedule

• The Offer Slope selection can be used to calculate the schedule’s offer when dispatched between MW segments

*Cannot be changed for today or the next day when the market is closed
Schedule Selection

The Schedule Selection web page is used to mark schedules as Available or Not Available and allows the user to modify the no load cost, cold start cost, intermediate start cost and hot start cost

- At least one cost-based schedule must be made available in both the Day-Ahead Market and in the Balancing Market

- Two price-based schedules available:
  a) Non-parameter limited
  b) Parameter limited
Schedule Restriction

• Used to identify operational restrictions due to
  – De-mineralized water
  – Emissions
  – Fuel

• Data entered will carry forward until updated by the user

• Dual Fuel Capability field
  – Mandatory field
  – Used to identify the ability of a unit to switch to an alternate type of fuel
Schedule Availability Update

• “Use Cost Schedule in Real Time Flag” must be selected between 14:15 - 21:00 Day before the operating day to be in effect
  – Yes
    • No price schedules will be available in Real-Time (except DA commitments)
    • Option to make cost schedules available/unavailable intraday
      (1 available cost schedule per fuel type, per hour)
  – No
    • Unit is not able to change Cost Schedule Availability in Real Time

• Notification Time changes on this display have priority over Notification Times on Unit Hourly Update and Schedule Detail pages
Intra-Day Cost Schedule Switching Process

- Schedules for uncommitted generators can be made available or unavailable hourly to more accurately reflect the resources cost
  
a) Sliding lock out
    
i. Can only change schedule availability three plus hours in advance of operating hour

- Committed resources are unable to change cost schedule availability for Day-Ahead or RAC committed hours
  
a) Units may change cost schedule availability for hours after the last DA/RAC committed hour
  
b) For RAC committed units, PJM Dispatch will provide a run profile

- Units committed in Real Time are unable to change cost schedules until released
  
  - Schedules can be changed in Markets Gateway, but PJM will run unit on committed schedule until released
  
  - Only exception would be if unit must switch fuels (i.e. gas → oil) after initial commitment and/or min run time met due to lack of fuel and still required by PJM

- Only 1 Cost Schedule (per fuel type) can be made available each hour
Parameter Limited Schedules
Parameter-Limited Schedules

- Generation resources shall submit and be subject to pre-determined limits on non-price offer parameters (“Parameter Limited Schedules”)

- Parameter limits are limitations that could be imposed on the parameters that generators submit as part of their offer

- PJM posts unit class specific parameter limits in Section 6.6 of Schedule 1 in the Operating Agreement
  - A Capacity Market Seller that does not believe its Generation Capacity Resource can meet the unit-specific values determined by the Office of the Interconnection due to actual operating constraints, and who desires to establish adjusted unit-specific parameters for those resources may request adjusted unit-specific parameter limitations.
For the 2016/2017 Delivery Year and subsequent Delivery Years, parameter limited schedules shall be defined for the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn Down Ratio</td>
<td>PJM OATT</td>
</tr>
<tr>
<td>Minimum Down Time</td>
<td>PJM OATT</td>
</tr>
<tr>
<td>Minimum Run Time</td>
<td>PJM OATT</td>
</tr>
<tr>
<td>Maximum Daily Starts</td>
<td>PJM OATT</td>
</tr>
<tr>
<td>Maximum Weekly Starts</td>
<td>PJM OATT</td>
</tr>
<tr>
<td>Maximum run Time</td>
<td>PJM OATT</td>
</tr>
<tr>
<td>Start-up Time</td>
<td>PJM OATT</td>
</tr>
<tr>
<td>Notification Time</td>
<td>PJM OATT</td>
</tr>
</tbody>
</table>

Additional Parameters for Base and CP resources
For the 2014/2015 through 2017/2018 Delivery Years, the following table specifies default parameter limited schedule values, by technology type, for generation resources not committed as Capacity Performance Resources:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Frame CT and Aero CT Units - Up to 29 MW ICAP</td>
<td>2.0 or Less</td>
<td>2.0 or Less</td>
<td>2 or More</td>
<td>14 or More</td>
<td>1.0 or More</td>
</tr>
<tr>
<td>Medium Frame CT and Aero CT Units - 30 MW to 65 MW ICAP</td>
<td>2.0 or Less</td>
<td>3.0 or Less</td>
<td>2 or More</td>
<td>14 or More</td>
<td>1.0 or More</td>
</tr>
<tr>
<td>Medium-Large Frame CT Units - 65 MW to 135 MW ICAP</td>
<td>3.0 or Less</td>
<td>5.0 or Less</td>
<td>2 or More</td>
<td>14 or More</td>
<td>1.0 or More</td>
</tr>
<tr>
<td>Large Frame CT Units - 135 MW to 180 MW ICAP</td>
<td>4.0 or Less</td>
<td>6.0 or Less</td>
<td>2 or More</td>
<td>14 or More</td>
<td>1.0 or More</td>
</tr>
<tr>
<td>Combined Cycle Units</td>
<td>4.0 or Less</td>
<td>6.0 or Less</td>
<td>2 or More</td>
<td>11 or More</td>
<td>1.5 or More</td>
</tr>
</tbody>
</table>
For the 2014/2015 through 2017/2018 Delivery Years, the following table specifies default parameter limited schedule values, by technology type, for generation resources not committed as Capacity Performance Resources:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum and Natural Gas Steam Units - Pre-1985</td>
<td>7.0 or Less</td>
<td>8.0 or Less</td>
<td>1 or More</td>
<td>7 or More</td>
<td>3.0 or More</td>
</tr>
<tr>
<td>Petroleum and Natural Gas Steam Units - Post-1985</td>
<td>3.5 or Less</td>
<td>5.5 or Less</td>
<td>2 or More</td>
<td>11 or More</td>
<td>2.0 or More</td>
</tr>
<tr>
<td>Sub-Critical Coal Units</td>
<td>9.0 or Less</td>
<td>15.0 or Less</td>
<td>1 or More</td>
<td>5 or More</td>
<td>2.0 or More</td>
</tr>
<tr>
<td>Super-Critical Coal Units</td>
<td>84.0</td>
<td>24.0 or Less</td>
<td>1 or More</td>
<td>2 or More</td>
<td>1.5 or More</td>
</tr>
</tbody>
</table>
Generator Fails the Three Pivotal Supplier Test (TPS)

Generators continue on their Price Schedule and non-limited parameters

Generators are placed on the lower production cost of the cost schedule or price schedule
Switched to Price Parameter-Limited Schedule

Capacity resources may be subject to their Price Parameter-Limited Schedule under the following circumstances:

I. For the 2014/2015 through 2017/2018 Delivery Years (non CP resources), the Office of the Interconnection:

   1. declares a Maximum Generation Emergency
   2. issues a Maximum Generation Emergency Alert
   3. schedules units based on the anticipation of a Maximum Generation Emergency or a Maximum Generation Emergency Alert for all, or any part, of an Operating Day.
Switched to Price Parameter-Limited Schedule

II. For Capacity Performance Resources, the Office of the Interconnection:

1. declares a Maximum Generation Emergency
2. issues a Maximum Generation Emergency Alert, Hot Weather Alert, Cold Weather Alert
3. schedules units based on the anticipation of a Maximum Generation Emergency, Maximum Generation Emergency Alert, Hot Weather Alert or Cold Weather Alert for all, or any part, of an Operating Day.
Switched to Price Parameter-Limited Schedule

III. For Base Capacity Resources, the Office of the Interconnection

1. declares a Maximum Generation Emergency during hot weather operations

2. issues a Maximum Generation Emergency Alert or Hot Weather Alert during hot weather operations

3. schedules units based on the anticipation of a Hot Weather Alert, or a Maximum Generation Emergency or Maximum Generation Emergency Alert during hot weather operations, for all, or any part, of an Operating Day.
Three Pivotal Supplier Test
The TPS test is a test for structural market power. The test examines the concentration of ownership of the supply compared to the level of demand.

- The test does not examine the competitiveness of offers or other factors. It is a test of ownership concentration relative to demand.

PJM utilizes the Three Pivotal Supplier (TPS) Test to mitigate market power for:

- Transmission Constraints
- Regulation Market
- RPM
- Shortage Pricing
A test failure means that the ownership of the supply needed is concentrated among few suppliers:

- Those suppliers have the potential to exercise market power (structural market power)
- It does not mean those suppliers are attempting to exercise market power
- A test failure triggers mitigation as a preventative step in the event of a concentration of ownership
Basic Theoretical Concepts of TPS

• Each supplier is ranked from largest to smallest offered MW of eligible supply

• If there are not enough MWs to satisfy the constraint without using the top two suppliers’ output plus the output of the supplier being tested, then those three suppliers are jointly pivotal

• Because the supply can be constrained by those three owners and the demand could potentially not be satisfied, they are considered to have structural market power

• If any test supplier fails, then the top two suppliers also fail
  – Resources that fail TPS are placed on the lower production cost of the cost schedule or price schedule
Questions?

**PJM Client Management & Services**
Telephone: (610) 666-8980
Toll Free Telephone: (866) 400-8980
Website: [www.pjm.com](http://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.
Real-Time Values
# Real-Time Value Overview

<table>
<thead>
<tr>
<th>Who Uses?</th>
<th>What Parameters?</th>
<th>Why Used?</th>
<th>How Are Parameters Communicated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP and Non-CP Resources</td>
<td>Turn Down Ratio Minimum Down Time Minimum Run Time Maximum Run Time Start Up Time (Hot/Warm/Cold) Notification Time</td>
<td>Meant to capture a resource’s current operational capabilities</td>
<td>Markets Gateway Tool Day Ahead: Parameter Limits tool Real Time: 1-Operational restrictions 2-Use hourly updates tab (Notification Time, Eco Min/Eco Max) AND Communicate to dispatch</td>
</tr>
<tr>
<td>When the resource cannot operate according to the unit specific parameters (CP and Base Capacity) or default PLS (non-CP) or exceptions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*A case by case evaluation will be completed for make whole payments*

- Not all Real Time Values qualify for make-whole payments (i.e.- Notification Time)
- Market Seller shall follow the “Temporary Exception” process if they request the modified operational parameters to be considered for ‘Make-Whole’ payments

* Tariff, Attachment K Appendix (Section 3.2.3)
Submitting Real-Time Values in Real Time:
Operational Restrictions Open Text Field

<table>
<thead>
<tr>
<th>Schedule Restriction Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Restriction Type 1</strong></td>
</tr>
<tr>
<td><strong>Operational Restriction Type 2</strong></td>
</tr>
<tr>
<td><strong>Operational Restriction Type 3</strong></td>
</tr>
<tr>
<td><strong>Operational Restriction Other</strong></td>
</tr>
</tbody>
</table>
Submit Exception Parameter Limits

The Exception Parameter Limits web page is used to submit a parameter limit exception request. On a daily basis, each generation supplier may submit notification to PJM that changed physical operational limitations at the unit require a temporary exception to the unit’s parameters. Each generation supplier must supply the required unit operating data in support of the exception.
Submit Exception Parameter Limits

The process and timeline for submitting a daily exception is as follows:

• By 10:30 am prior to the close of DAM
• Initial Deadline to request a parameter exception that will begin the next operating day
• PLS Schedules (both Price & Cost) will be revised in Markets Gateway to change the parameter limit for the next operating day
• Daily Exception Requests should be submitted via Markets Gateway by 1:30 pm prior to operating day (close of the DAM)
Submit Exception Parameter Limits

PJM must receive a complete exception request that includes:

- Unit Name
- Parameter Limit Requested
- Reason for Daily Exception Request
- eDart ticket
- Justification for Daily Exception Request, including required unit operating data in support of the exception
- Date on which the exception period will end. Exceptions granted may not continue past the beginning of the next period.