

## **PJM Regulation Market**

PJM State & Member Training Dept.





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 <u>automatic control</u>
- <u>Independent</u> of economic cost signal
- Obtainable within <u>five minutes</u>
- <u>Responds to frequency deviations</u>



- 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**





## **Regulation in Real-time Operations**

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### **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  $\Delta WW$  by multiplying the value by the ratio of  $\Delta WW/WW$  for the applicable signal for that offer

- **Cost Offer** Must meet Manual 15 Guidelines
  - **Capability Offer Cost** cost to reserve MW in \$/MW
    - Must be ≤ (fuel cost increase and unit specific heat rate degradation due to operating at lower loads) + \$12/MWh
  - **Performance Offer Cost** \$/MW cost Increase due to Heat Rate Increase during nonsteady state operation and Cost Increase in VOM
    - Converted to  $\Delta MW$  by multiplying the value by the ratio of  $\Delta MW/MW$  for the applicable signal for that offer

- 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 eMKT 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 eMKT System to support the cost-based regulation offer price

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- 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 eMKT 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

- 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

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### **Regulation Market Time Line**



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## **Regulation Market Timing**



## **Regulation Market Results**

What	Frequency	Location	When
			30 min prior to
Assignment	Hourly	еМКТ	top of hour
Clearing Price	Every 5 minutes	eData	Every 5 min

# Public $\rightarrow$ Market Results A/S $\rightarrow$ Regulation Results (Mileage and RTO average Performance Score)

<b>•SUITE</b>				> Logout	> Upload > E-mail					
Message	es Reports	Node List Market R Energ								
Regu	Ilation Results Sy	nchronized Reserve Resul	ts Primary Reserve I	Results DA Schedul	ng Reserve Results					
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Area:	PJM_RTO ▼ (mm	Date: 06/02/2013 /dd/yyyy) Change Dat	e						Get	t CSV Report
Regulatio Hour	n Results for 06/02/2 Requirement	013 Reg D Self Scheduled	Reg A Self Scheduled	Reg D Procured	Reg A Procured	Total	Deficiency	RTO Avg Performance Score	Reg A Mileage	Reg D Mileage
01	499.5	81.3	101.3	3.6	313.3	499.5	0	0.75	6.40	16
02	503	81.4	73.3	3.6	344.7	503	0	0.73	6.40	16
03	503	81.4	51	3.6	367	503	0	0.83	6.40	16
04	503	81.4	51	3.6	367	503	0	0.72	6.40	16
05	503	81.4	249.8	3.6	168.2	503	0	0.79	6.40	16
06	748.1	84.4	175.4	3.7	484.6	748.1	0	0.76	6.40	16
07	748.1	79.6	51	3.7	613.8	748.1	0	0.80	6.40	16
80	748.1	79.6	306.2	3.7	358.6	748.1	0	0.79	6.40	16
09	748.1	79.6	300.9	3.7	363.9	748.1	0	0.83	6.40	16
10	748.1	79.6	250.2	3.7	414.6	748.1	0	0.77	6.40	16
11	748.1	79.6	312.2	3.7	352.6	748.1	0	0.75	6.40	16
12	748.1	79.6	304.7	3.7	360.1	748.1	0	0.83	6.40 6.40	16
12	740.4									16
13 14	748.1	79.6	261.5	3.7	403.3 405.1	748.1	0	0.72	6.40	16

From the Public reports under the Regulation Results tab

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#### Generator $\rightarrow$ Market Results $\rightarrow$ Regulation and Reserve Award



## Managing Regulation Data

#### The following eMKT 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 modify regulation resource availability and parameters on an hourly basis
- **Regulation Bilateral Transactions** use this web page to facilitate a regulation bilateral transaction

#### **eMKT** Materials

#### eMKT



eMKT allows PJM members to submit information and obtain data needed to conduct business in the Day-Ahead, Regulation and Synchronized Reserve markets.

Login | Register

eMKT Documents	Date
eMKT Incident Report - April 2008 (PDF)	
Sample file for Six Digit Precision of Aggregates in Day Ahead CSV File (CSV	()
eMKT Frequently Asked Questions (PDF)	08.17.2011
2012 Spring Psylight Savings Transition Information (PDF)	03.06.2012
eMKT User Guide (PDF)	06.01.2012
Market Database Dictionary (PDP)	11.23.2011
External Interface Specification Guide for eMKT - Rev 25 (effective 06.22.2012) (PDF)	07.11.2012
eMKT XML Schema (XSD)	06.26.2012
eMKT XML Schema - Including Shortage Pricing and Performance-Based Regulation - Effective 09.24.2012 (XSD)	08.21.2012

#### eMKT Documentation

#### http://www.pjm.com/markets-and-operations/etools/emkt.aspx

Unit	Schedules	Dispatch Lambda Market Re	ults Regulation Market Synchronized Nonsy Reserve Market Rese	nchronized DA Scheduling rve Market Reserve Market Parameter Limits	Interface Pricing Opportunity Cost Calculator
Unit Hourly	/ Updates	Unit Detail	Energy Ramp Rates Syncl	Res Ramp Rates Weather Forecas	t Wind Forecast
Init Detail Sea	rch				Get Report
Portfolio:	•	Unit:	• (mm,	Date: 12/27/2013	Get CSV Report
Init Detail Res		on 1	2/27/2013		
	Name		Value	Name	Value
Type Of Unit			Single Boiler	Plant Name	
Jnit Number			1	Unit Shortname	
Node				Operating Company	
Capacity Resource	ce		Yes	Regulation Resource	Yes
Default Status			MustRun	Default Ramp Rate	1.0
Fixed Gen.			No	Self Supply	No
Fixed Gen. Emergency Min(N	4W)			Self Supply Emergency Max(MW)	No 52.0

- 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

(null)

0

• If you enter zero (the default values) then 100% of the assigned Regulation MW (divided by 5) will reduce the bid-in energy ramp rate for SCED

20.0 Regulation Max(MW)

Spinning Max(MW)

Use Extended Cold

• Note: Hourly updates are made on the Regulation Update screen, not the Unit Hourly Screen

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CIF

Regulation Min(MW)

Reduced Ramp Rate (%)

01/27/2015

52.0

52.0

No

Unit	Schedules	Dispat	ch Lamb	da Market	Results Reg	lation Marke	et Synchroniz Reserve Ma			DA Scheo Reserve N		Con Ed	Para	meter Limi	ts Interfa		tunity Cost Iculator	
Regulation Of	fers	F	legulatio	n Updates	F	Regulation B	ilaterals											
ulation Offers	Search												G	et Report				
						Date	12/27/2	013					-		-			
tfolio:	▼ Unit	5 k			•	(mm/dd/yy								Get CSV Rep	oort			
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es: 1234	Next		-													Records: 1	- 10 of 3	5 matcr
ulation Offers	<b>Results</b> for	ALL LO	CATIO	NS on 12/	27/2013													
omit																		
	Area	Reg	Offer	Capability	Performance	Capability	Performance	Heat Rate	Heat Rate	VOM	Fuel	Energy	Eco Max	Reg Min	Min	Availabla Statue	Self	Rolling Av
Location	Area					Capability Offer Cost	Performance Offer Cost	Heat Rate @ Eco Max	Heat Rate @ Reg Min	VOM Rate	Fuel Cost	Energy Storage Loss	Eco Max MW	Reg Min MW	Min Offer MW	Available Status	Self Scheduled	Rolling A Performa Score
Location	Area PJM_RTO	Reg	Offer	Capability	Performance	and the second second	a contract strend to be	and the second se		and the second second		Storage	and the second se		Offer	Available Status Not Available		Performa
Location Steamer 1		Reg Type	Offer MW	Capability Offer Price	Performance Offer Price	Offer Cost	Offer Cost	@ Eco Max	@ Reg Min	Rate	Cost	Storage Loss	MW	MW	Offer MW			Performa Score
Location Steamer 1 Steamer 2	PJM_RTO	Reg Type A	Offer MW	Capability Offer Price 0.00	Performance Offer Price (null)	Offer Cost (null)	Offer Cost (null)	@ Eco Max (null)	@ Reg Min (null)	Rate (null)	Cost (null)	Storage Loss (null)	MW 52	MW 20	Offer MW 0.0	Not Available	Scheduled	Performa Score (null)
Location Steamer 1 Steamer 2 Steamer 3	PJM_RTO PJM_RTO	Reg Type A A	Offer MW 0 15	Capability Offer Price 0.00 6.30	Performance Offer Price (null) 0.30	Offer Cost (null) 12.31	Offer Cost (null) 0.30	@ Eco Max (null) 9662	@ Reg Min (null) 9714	Rate (null) 0	Cost (null) 2.35	Storage Loss (null) (null)	MW 52 585	MW 20 425	Offer MW 0.0 5.0	Not Available Available	Scheduled	Performa Score (null) (null)
Location Steamer 1 Steamer 2 Steamer 3 Steamer 4	PJM_RTO PJM_RTO PJM_RTO	Reg Type A A A	Offer MW 0 15 16	Capability Offer Price 0.00 6.30 12.33	Performance Offer Price (null) 0.30 0.29	Offer Cost (null) 12:31 12:33	Offer Cost (null) 0.30 0.29	@ Eco Max (null) 9662 9837	@ Reg Min (null) 9714 9890	Rate (null) 0	Cost (null) 2.35 2.38	Storage Loss (null) (null) (null)	MW 52 585 585	MW 20 425 425	Offer MW 0.0 5.0 10.0	Not Available Available Available	Scheduled - -	Performa Score (null) (null) (null)
Location Steamer 1 Steamer 2 Steamer 3 Steamer 4 Steamer 5	PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO	Reg Type A A A A	Offer MW 0 15 16 10	Capability Offer Price 0.00 6.30 12.33 8.28	Performance Offer Price (null) 0.30 0.29 0.67	Offer Cost (null) 12.31 12.33 12.28	Offer Cost (null) 0.30 0.29 0.67	@ Eco Max (null) 9662 9837 10714	@ Reg Min (null) 9714 9890 10761	Rate (null) 0 0	Cost (null) 2.35 2.38 2.94	Storage Loss (null) (null) (null) (null)	MW 52 585 585 630	MW 20 425 425 425	Offer MW 0.0 5.0 10.0 3.0	Not Available Available Available Available	Scheduled - - -	Performa Score (null) (null) (null) (null)
Location Steamer 1 Steamer 2 Steamer 3 Steamer 4 Steamer 5 Steamer 6	PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO	Reg Type A. A A A A	Offer MW 0 15 16 10 11	Capability Offer Price 0.00 6.30 12.33 8.28 9.17	Performance Offer Price (null) 0.30 0.29 0.67 0.39	Offer Cost (null) 12:31 12:33 12:28 15:17	Offer Cost (null) 0.30 0.29 0.67 0.39	@ Eco Max (null) 9662 9837 10714 10352	@ Reg Min (null) 9714 9890 10761 11457	Rate (null) 0 0 0 0	Cost (null) 2.35 2.38 2.94 4.03	Storage Loss (null) (null) (null) (null)	MW 52 585 585 630 339	WW 20 425 425 425 425 141	Offer MW 0.0 5.0 10.0 3.0 2.0	Not Available Available Available Available Available Available	Scheduled	Performal Score (null) (null) (null) (null)
Location Steamer 1 Steamer 2 Steamer 3 Steamer 4 Steamer 5 Steamer 6 Big CC 1	PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO	Reg Type A A A A A A A	Offer MW 0 15 16 10 11 8 10	Capability Offer Price 0.00 6.30 12.33 8.28 9.17 7.49 12.57	Performance Offer Price (null) 0.30 0.29 0.67 0.39 0.57 0.48	Offer Cost (null) 12.31 12.33 12.28 15.17 13.49 13.57	Offer Cost (null) 0.30 0.29 0.67 0.39 0.57 0.48	@ Eco Max (null) 9662 9837 10714 10352 10671 11173	@ Reg Min (null) 9714 9890 10761 11457 11377 11377	Rate (null) 0 0 0 0 0 0 0	Cost (null) 2.35 2.38 2.94 4.03 3.26 3.27	Storage Loss (null) (null) (null) (null) (null) (null)	MW 52 585 585 630 339 400 400	WW 20 425 425 425 141 160 160	Offer MW 0.0 5.0 10.0 3.0 2.0 2.0 3.0	Not Available Available Available Available Available Available Available	Scheduled 	Performal Score (null) (null) (null) (null) (null) (null)
	PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO PJM_RTO	Reg Type A A A A A A	Offer MW 0 15 16 10 11 8	Capability Offer Price 0.00 6.30 12.33 8.28 9.17 7.49	Performance Offer Price (null) 0.30 0.29 0.67 0.39 0.57	Offer Cost (null) 12.31 12.33 12.28 15.17 13.49	Offer Cost (null) 0.30 0.29 0.67 0.39 0.57	@ Eco Max (null) 9662 9837 10714 10352 10671	@ Reg Min (null) 9714 9890 10761 11457 11377	Rate (null) 0 0 0 0 0	Cost (null) 2.35 2.38 2.94 4.03 3.26	Storage Loss (null) (null) (null) (null) (null)	MW 52 585 585 630 339 400	WW 20 425 425 425 141 160	Offer MW 0.0 5.0 10.0 3.0 2.0 2.0	Not Available Available Available Available Available Available	Scheduled - - - - - - - -	Performa Score (null) (null) (null) (null) (null)

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Unit	Schedules Disp	batch Lambda Market R	esults Regulation	Market Synchronized Reserve Market	Nonsynchronized Reserve Market	DA Scheduling Reserve Market	Con Ed Param	eter Limits Interface	Pricing	pportunity Cost Calculator
Regulation	n Offers	Regulation Updates	Regulat	ion Bilaterals						
egulation Upd	lates Search								Get Report	
Portfolio:	· ·	Unit;		•	Da (mm/dd/	te: 12/27/20 (yyyy) Change			Get CSV F	leport
lourly Values		Apply To:	08-23 🔻	Apply	Use Defaults					
Reg A MW 75	75 0 Reg D 0 MW	450 Reg Min 450 MW	700 Reg Max 700 MW	Reg A Commit Available Status	Reg D ▼ Commit Av Status	ailable 🔻	0 Reduced Ramp Rate (%)			
egulation Upd Submit	lates for		on 12/27	7/2013						
Hour Ending	Regulation Min MW	Regulation Max MW	Reg A MW	Reg A Self Scheduled	Reg A Available	Reg D MW	Reg D Self Scheduled	Reg D Available	Spilling	Reduced Ramp Rate (%)
01	150	246	75	+	Available	(null)	-	Available	-	
02	150	246	75	+	Available	(null)		Available	-	
03	150	246	75	+	Available	(null)	+	Available	+	
04	150	246	75	÷	Available	(null)	100	Available	:=	
05	150	246	75	÷	Available	(null)	+	Available	+.	And the second second second
06 07				• •			e Regulation O	· · · · · · · · · · · · · · · · · · ·		
08	ending. <b>Th</b>	ne deadline f	or enterin	g the Regulat	ing Update	es is 60 m	ninutes prior t	o the begin	nning o	of the 🛛 🛁
09							e for hour end			
10				-		n opuat			St De I	
11	13:00 (beg	inning of hou	ur ending	14)						
12	150	246	75		Available	CoulD		Available	-	
13	150	246	75		Available	(null) (null)		Available		
14	150	246	15	-	Available	(nuit)		Available		
15	150	246	75		Available	(null)		Available		

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## **Regulation Bilaterals**

ard.	SUITE			>Logoul >E-mail			
0	Unit Schedul	es Dispatch Lambda Market Resi	ults Regulation Market Synchroniz Reserve Mar	ed Nonsynchronized DA Scheduling Con Ed ket Reserve Market Reserve Market	Parameter Limits Interface Pricing Opp	ortunity Cost Calculator	
	Regulation Offers	Regulation Updates	Regulation Bilaterals				
	<b>Regulation Bilaterals</b>					Get Report	
	Date: C	October-2014 ·					
la:	L					Get CSV Report	
e	Pages: 1						
	Regulation Bilaterals Res Add Delete Submit	ults					
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Start Date	Hour	Stop Date	Hour	Area
10/11/2014	01	10/11/2014	24	PJM_RTO



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## **Questions** ?

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