Demand Side Response in the Ancillary Service Markets

PJM State & Member Training Dept.

Disclaimer:

PJM has made all efforts possible to accurately document all information in this presentation. The information seen here does not supersede the PJM Operating Agreement or the PJM Tariff both of which can be found by accessing: http://www.pjm.com/documents/agreements/pjm-agreements.aspx

For additional detailed information on any of the topics discussed, please refer to the appropriate PJM manual which can be found by accessing: http://www.pjm.com/documents/manuals.aspx

Objectives

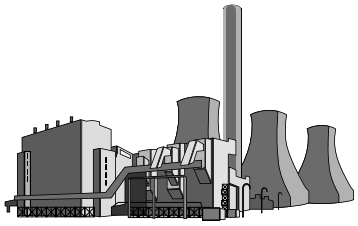
- Explain the purpose and features of Demand Side Response in the PJM Market Based Regulation Market
- Explain the purpose and features of Demand Side Response in the PJM Synchronized Reserve Market
- Explain the purpose and features of Demand Side Response in the PJM Day Ahead Scheduling Reserve Market

Agenda

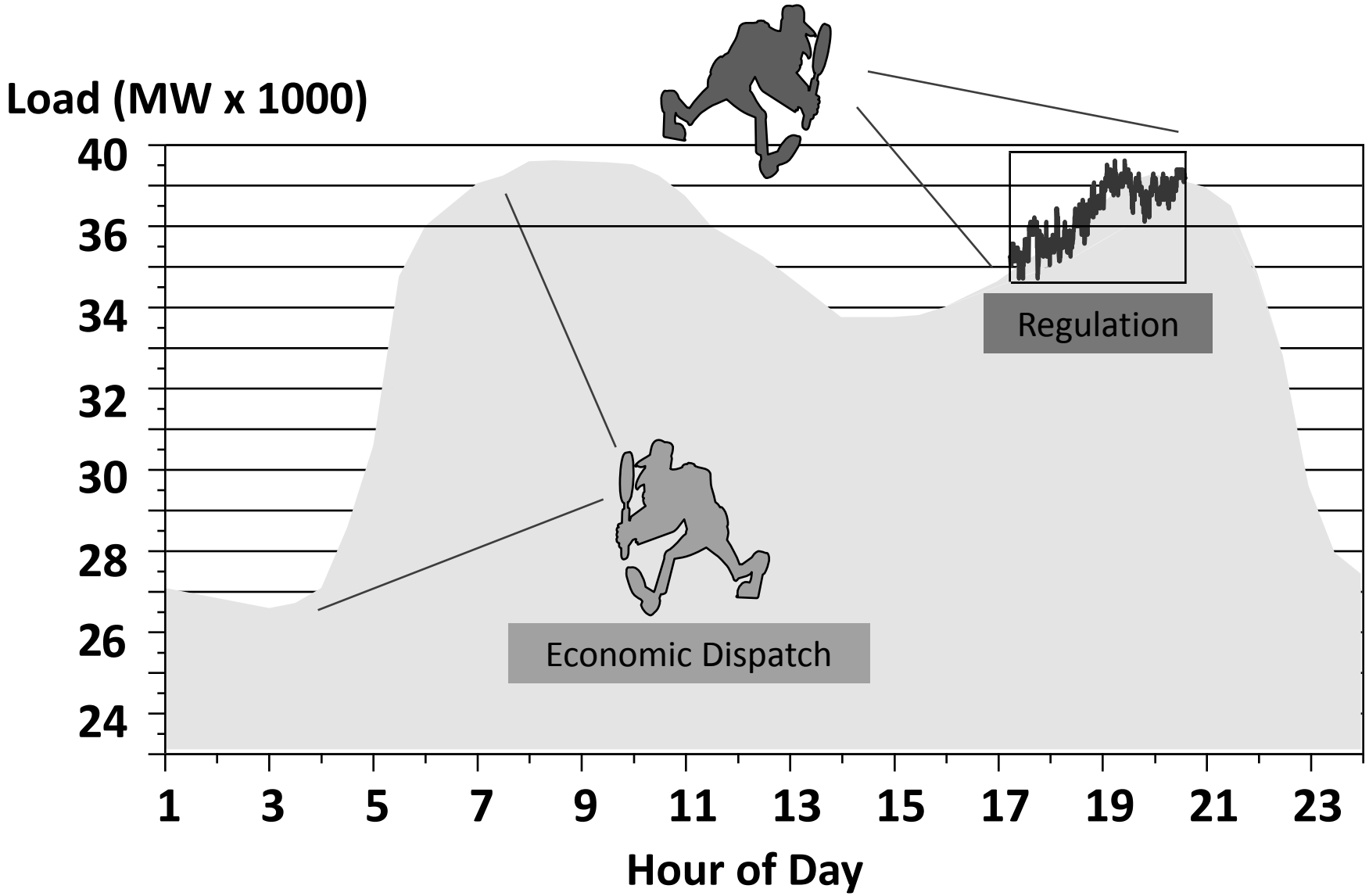
- **Market-based Regulation**
  - **Market-based Regulation Overview**
  - Request Regulation Participation in eLRS
  - Regulation Participation through eMKT
  - Regulation Performance and Settlements
  - Performance Groups
  - Regulation Load Data Retention Guidelines
- Synchronized Reserve Market
- Day Ahead Scheduling Reserve Market

What is Regulation?

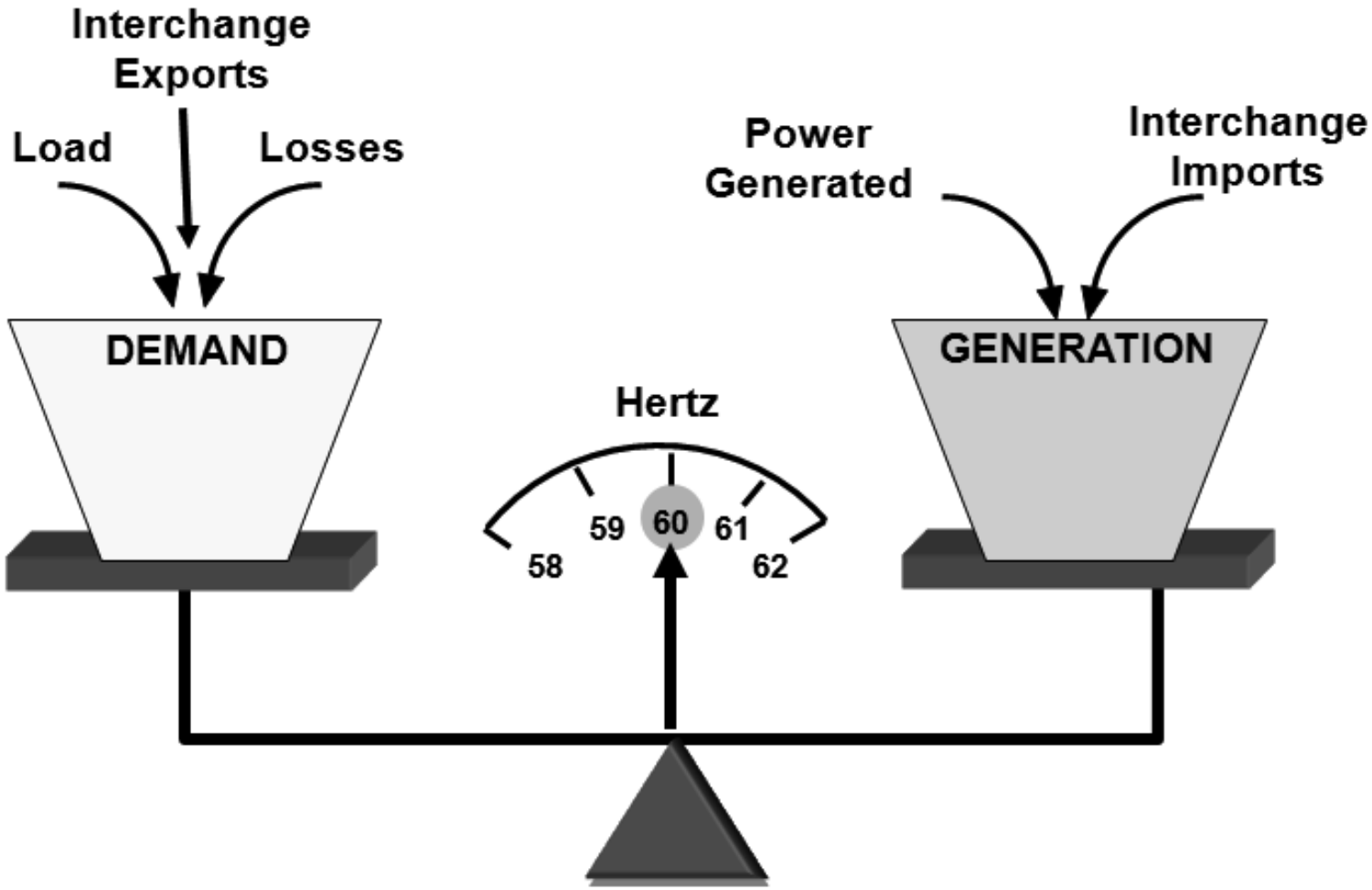
- **Definition:**
  - A variable amount of generation energy under automatic control which is independent of economic cost signal and is obtainable within five minutes
- Generating units or Demand Response Resources that provide fine tuning that is necessary for effective system control
- Governors respond to minute-to-minute changes in load
- Regulating resources correct for small load changes that cause the power system to operate above and below 60 Hz for sustained period of time



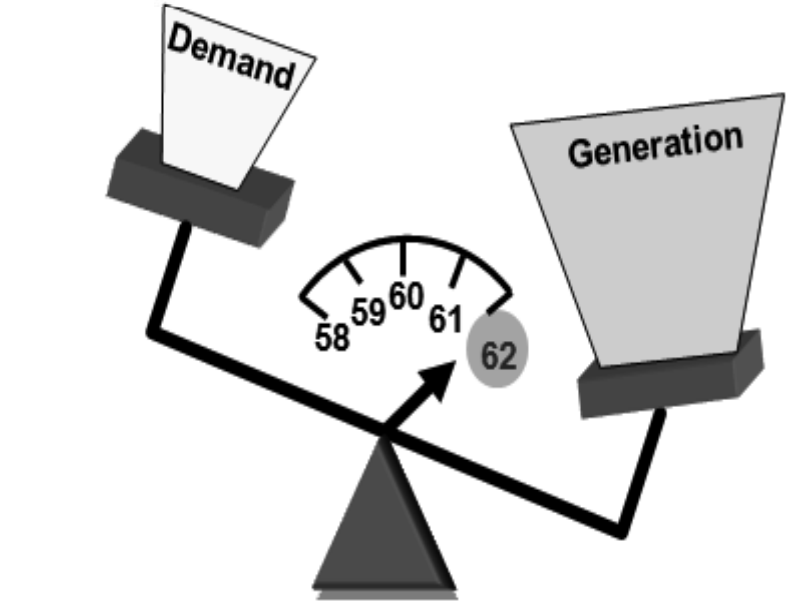
Regulation vs Economic Dispatch

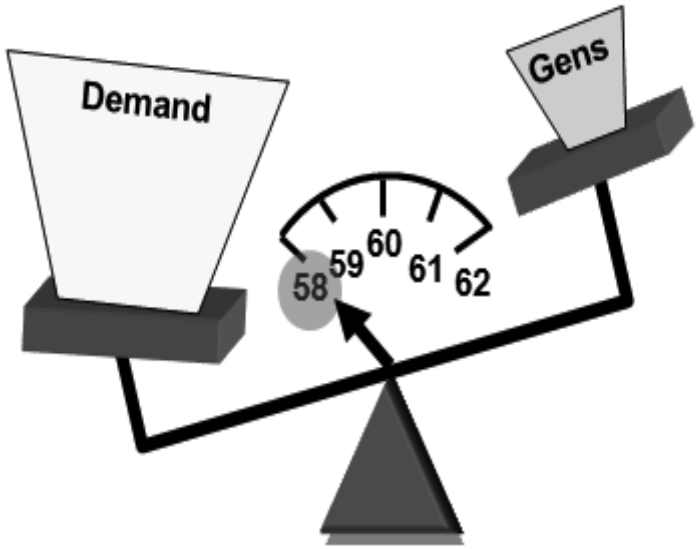


Balancing Authority's Goal



Imbalance Conditions





Over-generation

- Total Generation > Total Demand
- Frequency > 60 Hertz
- Generators momentarily speed up

Under-generation

- Total Generation < Total Demand
- Frequency < 60 Hertz
- Generators momentarily slow down

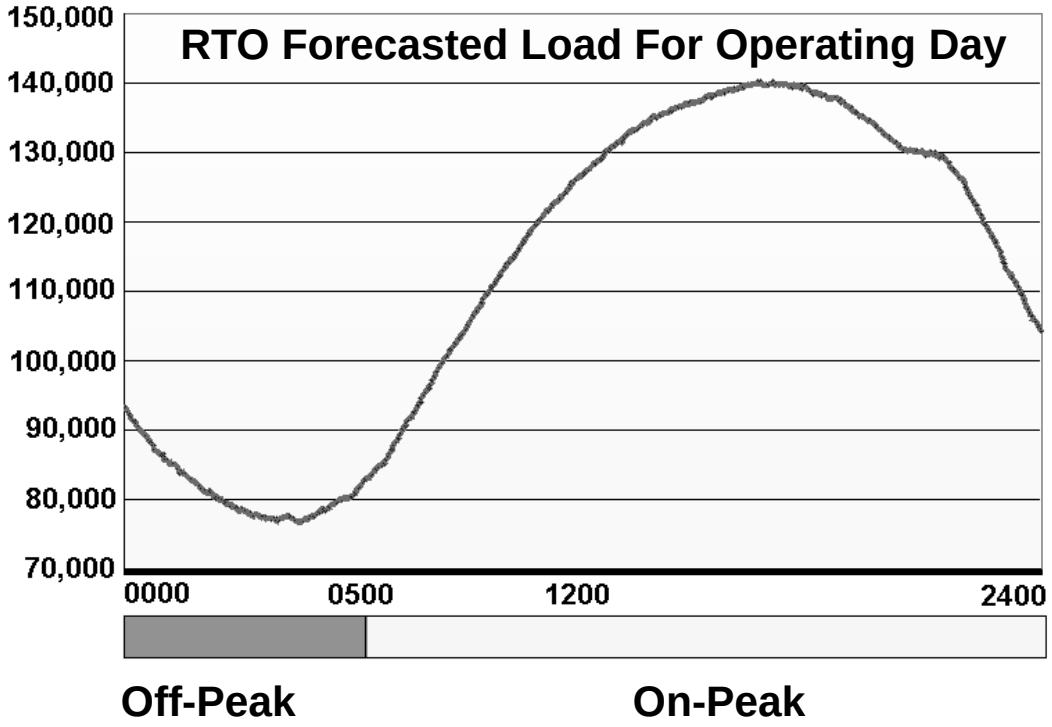
PJM Market with Market-based Regulation

- Creates single Regulation market for entire RTO
- Provides Market Clearing Price for regulation
- Protects supplier by providing opportunity cost of energy
- Provides more incentive to provide regulation

PJM's Regulation Requirement

The RTO requirement is a fixed number for the on and off peak periods with a reevaluation every 6 months

- Requirement for off-peak hours (0000-0459)
  - 525 MW
- Requirement for on-peak hours (0500-2359)
  - 700 MW



Real-time Regulation Data/Terms

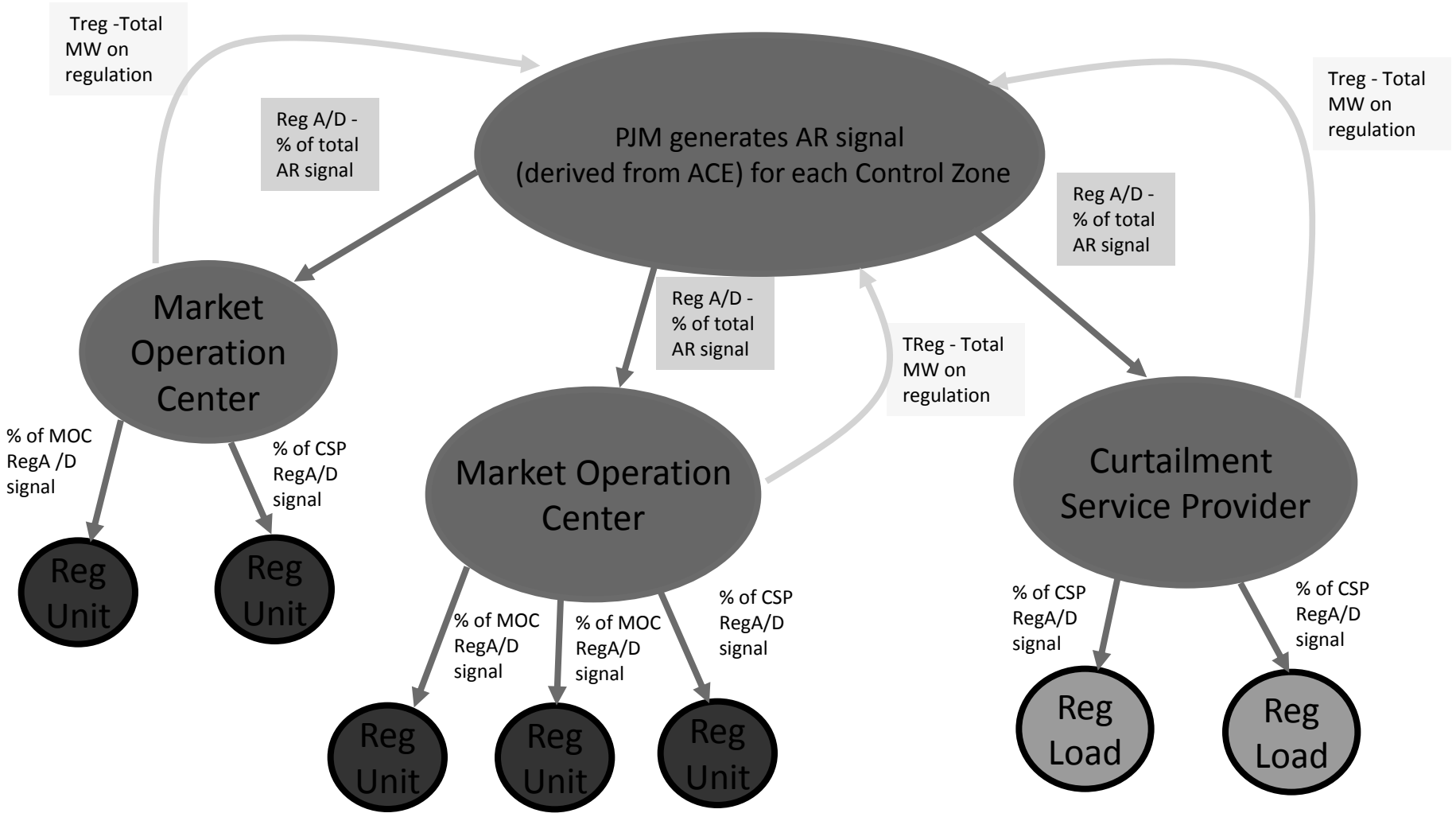
- **ARegA or ARegD – Assigned Regulation**
  - This is the assigned hourly regulation quantity (MW) that is cleared from the regulation market
  - It is assigned for each individual resource that is qualified to regulate in the PJM market
  - This value, although typically static for the hour, will be sent by PJM on a 10 second scan rate
  - Resources will receive a separate assignment for RegA and RegD if the regulating resource is dual qualified, but the regulating resource will be assigned to follow only one signal for the hour
- **RegA or RegD – Regulation Control Signal**
  - Real-time instantaneous resource owner fleet regulation signal (+/- MW) sent from PJM to the resource owner
  - This signal is used to move regulating resources in the owner's fleet within the fleet capability (+/- TReg)
  - This value will be sent on a 2 second scan rate
    - RegA-is the low filter ACE signal sent to traditional regulating resources
    - RegD-is the high filter ACE signal sent to dynamic regulating resources

Real-time Regulation Data/Terms

- **TRegA or TRegD – Total Regulation**
  - Real-time fleet regulation capability (MW) sent from Resource owner to PJM that represents the active resource owner's ability to regulate
  - Ideally the value of this quantity should be the sum of the resource owner's non-zero AReg quantities for the majority of the hour, but must reflect any reductions in regulating capability as they occur
    - resource's AGC limit restrictions, resource "off control" conditions, etc.
  - This value shall be calculated every 2 seconds and sent on a 2-second scan rate
  - A fleet owner must separate the fleet so resources following RegA report TRegA and resources following RegD report TRegD

- **CRegA or CRegD – Current Regulation**
  - Real-time fleet regulation feedback (+/- MW) sent from Resource owner to PJM that represents the active position of the fleet with respect to the +/- TReg capability
  - Ideally, the value of this quantity will track the RegA signal if the regulating fleet is responding as prescribed
  - Calculated every 2 seconds and sent on a 2-second scan rate
  - Must separate the fleet so resources following RegA report CRegA and resources following RegD report CRegD

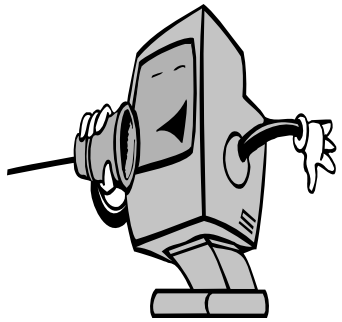
Regulation in Real-time Operations



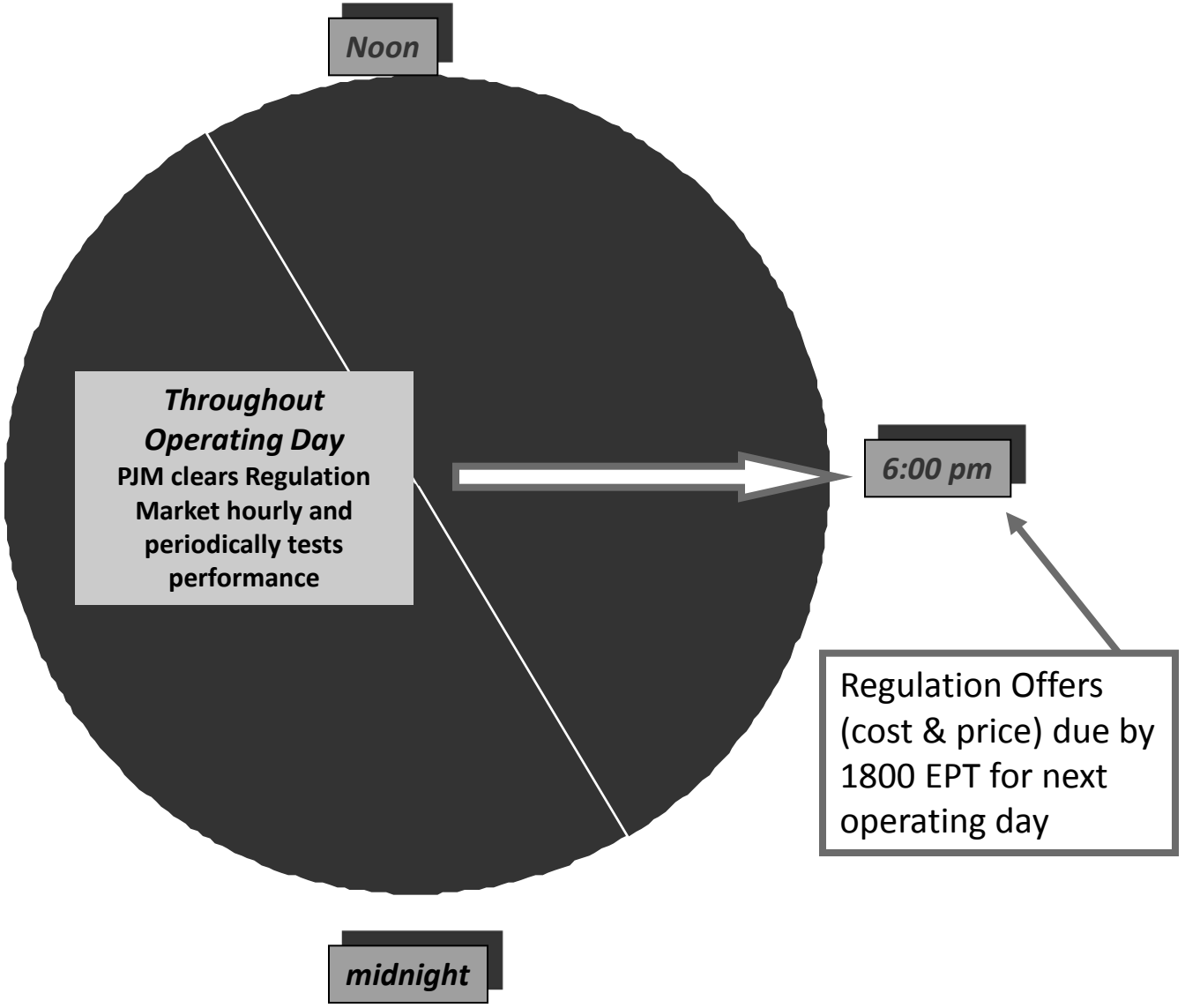
* Note: CSP must reverse sign of AR signal for Demand Resources

Synchronized Reserve and Regulation Optimization

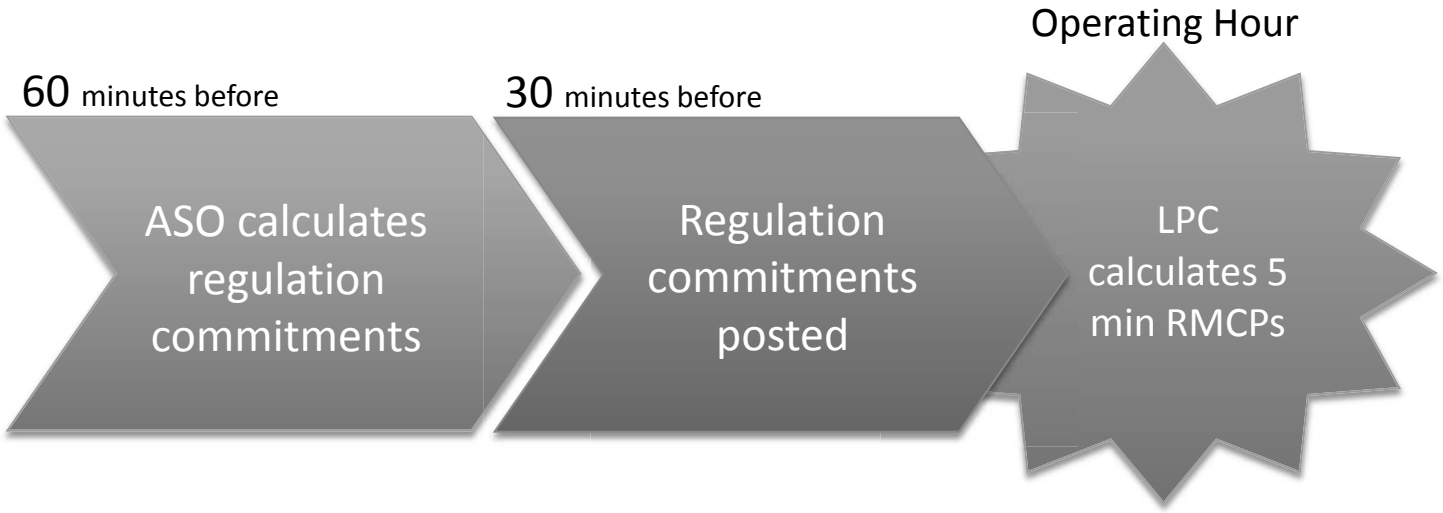
- Using hour-ahead regulation availability, amount, and forecasted LMPs:
  - Software co-optimizes Regulation and Synchronized Reserve assignments to minimize cost of both products and energy (ASO)
  - Synchronized Reserve and Regulation assignments for next hour are posted on eMKT
    - Units cannot be committed for both Synchronized Reserve and Regulation during the same hour



Regulation Market Time Line



Regulation Market Timing



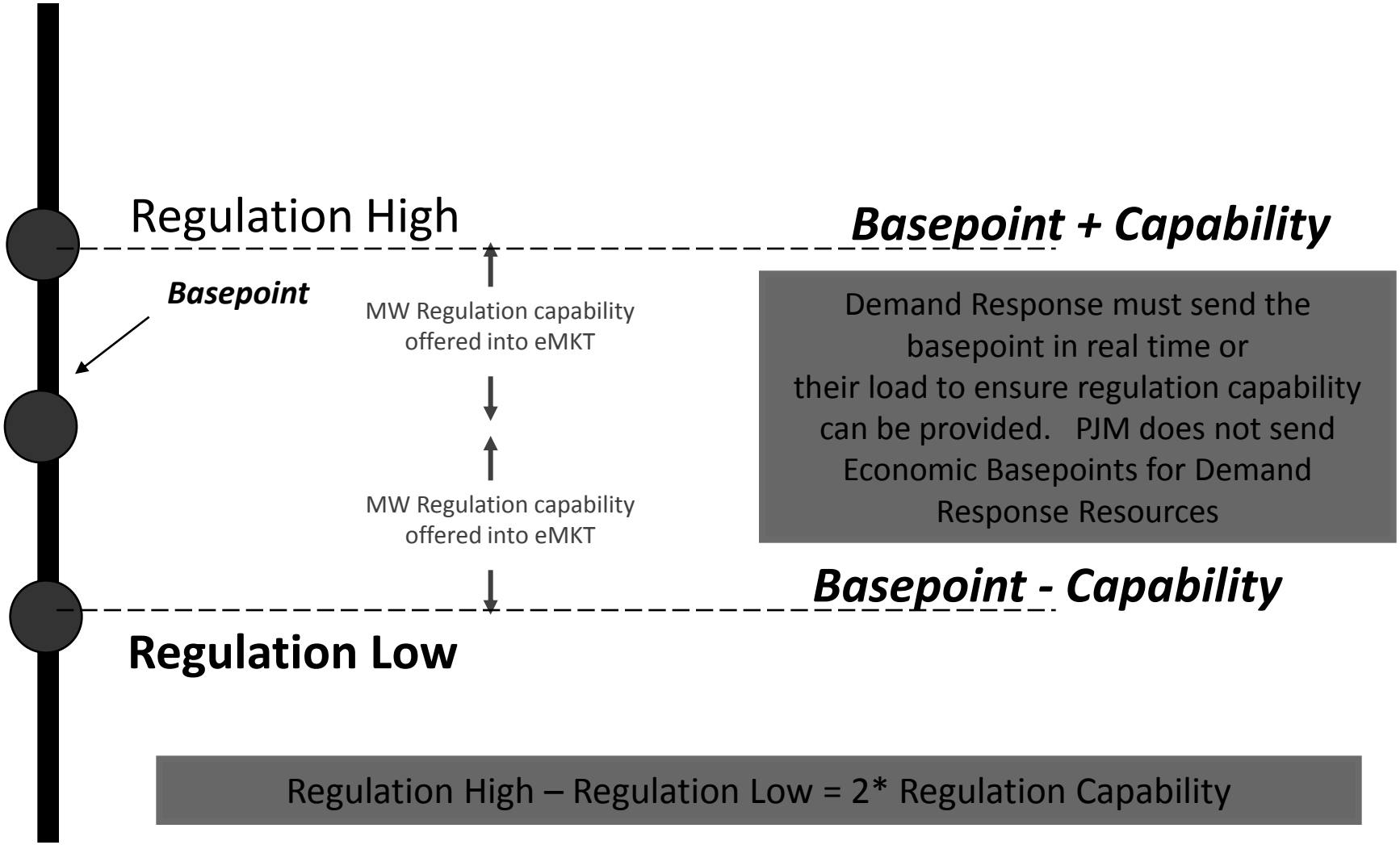
Regulation Market Timing

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

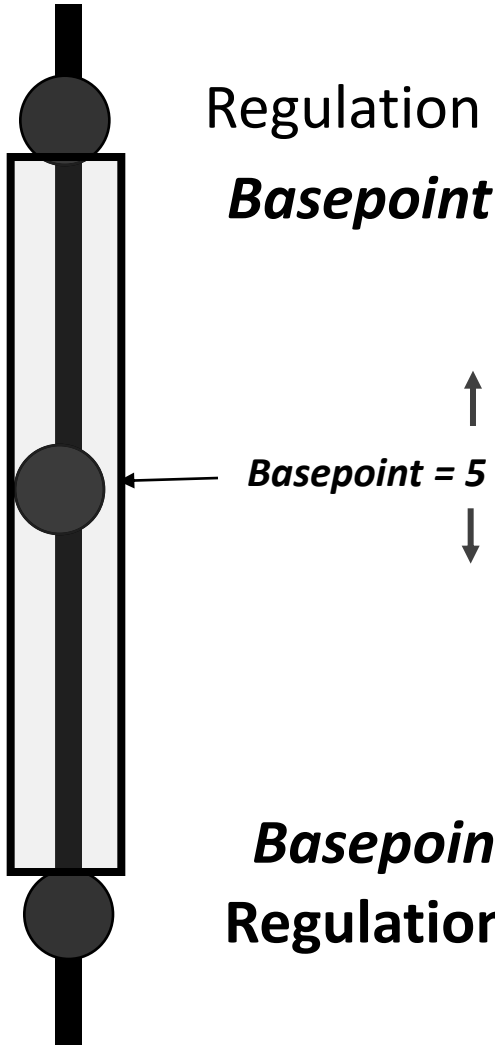
Participation Requirements

- Ability to receive and react to a dynamic regulation control signal from PJM
- Real time telemetry
- Five-minute response (raise or lower load within specified bandwidth)
- Minimum .1 MW offer
- Resource certification and testing requirements
- Demand Resources are limited to providing 25% of the Regulation requirement

Band of Regulation for Demand Response



Regulation for Demand Response Example



Regulation High = 7 MW

Basepoint + Capability

Basepoint = 5

Basepoint - Capability

Regulation Low = 3 MW

Demand is normally a 5 MW load

They are offering 2 MW of regulation
Regulation High Limit = 7 MW
Regulation Low Limit = 3 MW

Regulation Limits can be changed hourly

Regulation Qualification Test

- Resources must meet the following criteria:
  - Pass three consecutive tests with a performance score of 75% or better
  - The resource will follow the RegA or RegD signal for 40 minutes using more operational tests
    - Resources may complete one self-test and two PJM administered tests
    - Or three PJM administered tests
  - Resources can dual qualify for RegA and RegD by completing additional tests

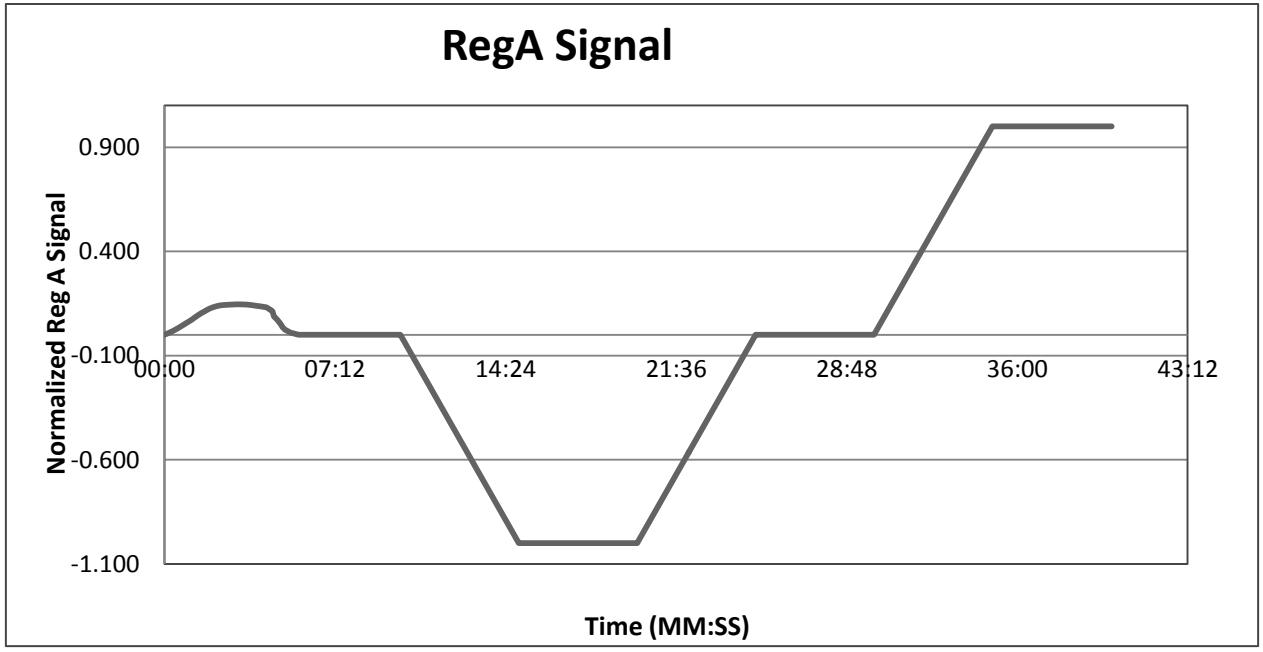
Regulation Qualification Test

- To perform a self test the member must use the PJM test shape posted on the Markets and Operations> Ancillary Services>Market Based Regulation page fed into the resource owner‘s EMS. Additionally, the member must notify the PJM Performance Compliance at least 60 minutes before the test. The Resource owner should also notify PJM Dispatch who will make a determination whether the test can be run. The resource should be set to unavailable during the test, though the other units may continue to regulate. Up to three self administered tests may be performed on a resource each day

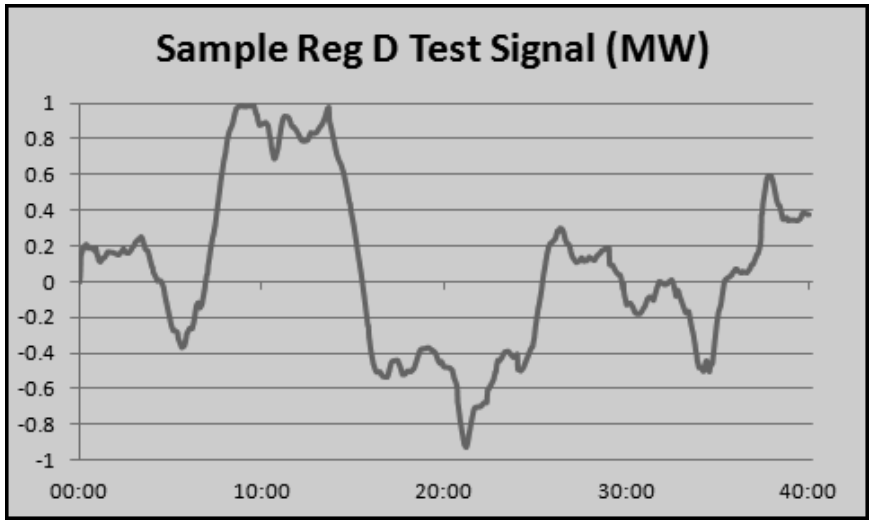
- The remaining tests should be administered by PJM Dispatch. The resource owner should contact PJM Dispatch and PJM Performance Compliance at least 60 minutes before the test though 24 hour notice is preferred. For a PJM administered test, all resource(s) will be taken out of the regulation market for the specific signal. PJM Dispatcher makes the final determination about whether a PJM administered test can be performed. Only one PJM administered test may be performed on a resource each day

Regulation A Test

- Follow the RegA Test Signal posted on pjm.com under Markets & Operations>Ancillary Services>Market Based Regulation



Regulation D Test



Resources that wish to qualify for RegD must:

- Contact RealTimeDataManagement@pjm.com and ask that the RegD signal, TREGD, AREGD be added to your ICCP/DNP link
- One self test may be completed using the RegD Test Signal posted on pjm.com under Markets & Operations>Ancillary Services>Market Based Regulation
- This test will be scored by PJM Performance Compliance using the Performance Score Calculation as described in ***Manual 12- Balancing Operations, §4.5.6 Performance Score Calculation***

Mandatory Training Requirement

CSP's that have resources participating in Synchronized Reserves and/or Regulation, need to designate the individuals at their company that interface with these markets and have them take a mandatory annual training. The following is the procedure for a company to "sign-up" each individual for the mandatory training.

The first step is for the company to designate a Training Liaison (point person in charge of monitoring that individuals have completed the initial training and subsequent refresher training).

a) Send the Training Liaison Identification Form (DOC) found on the Member Training Liaison webpage http://pjm.com/training/member-training-liaison.aspx to trainingsupport@pjm.com
   - Select CSP for Company Type on the form.

b) PJM will send the designated Training Liaison a spreadsheet to populate the company's roster with the information on the individuals who will be interfacing with the Regulation and/or Synchronized Reserve Markets.

The second step is to send the populate spreadsheet to trainingsupport@pjm.com. Those individuals will be added to the company roster and given access to the mandatory training.

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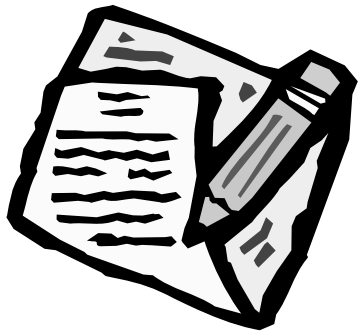


Request Regulation Participation in eLRS

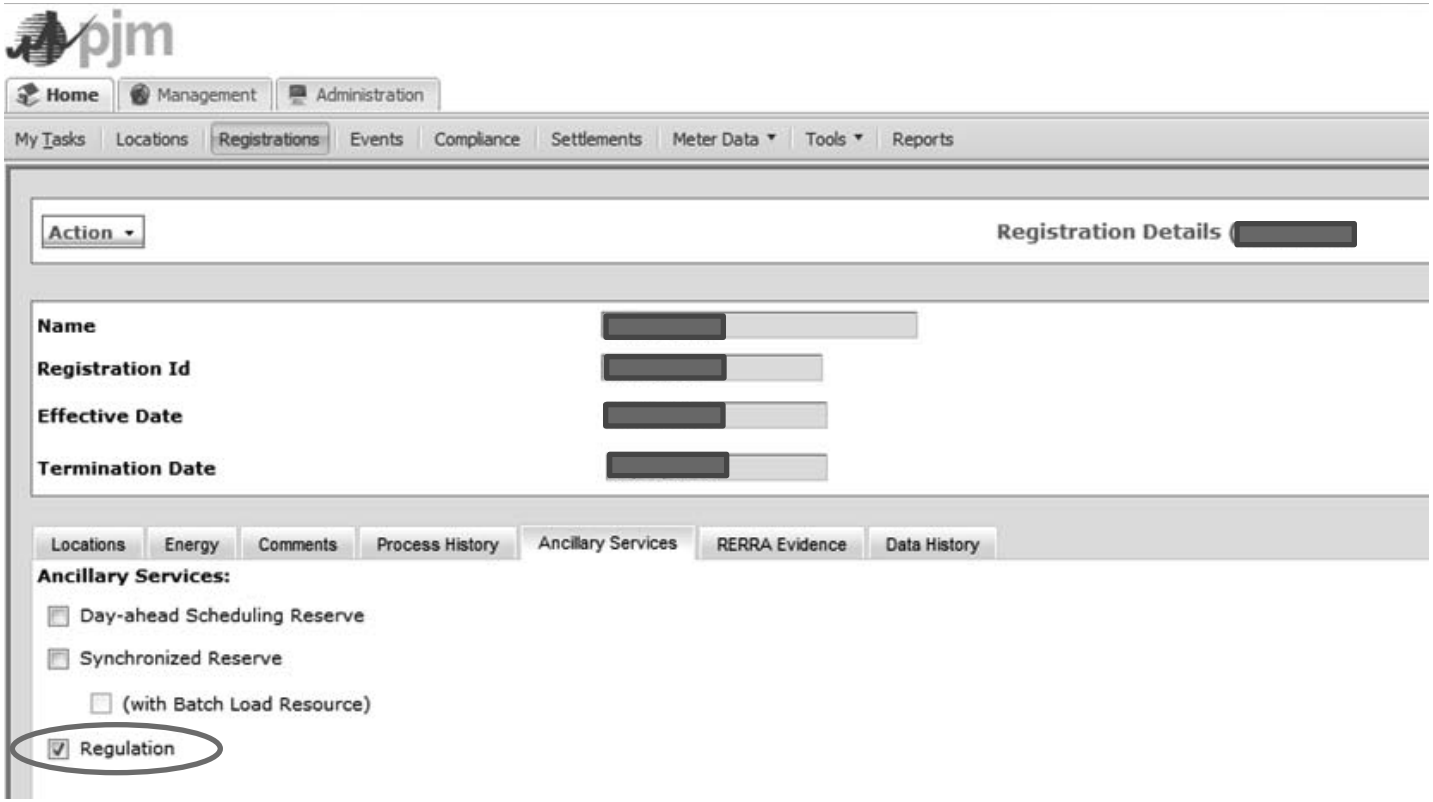
DSR resources must be approved by PJM prior to participating in the Regulation Market

- There must be a confirmed Economic registration in eLRS prior to requesting Regulation participation.

Request Regulation Participation in eLRS

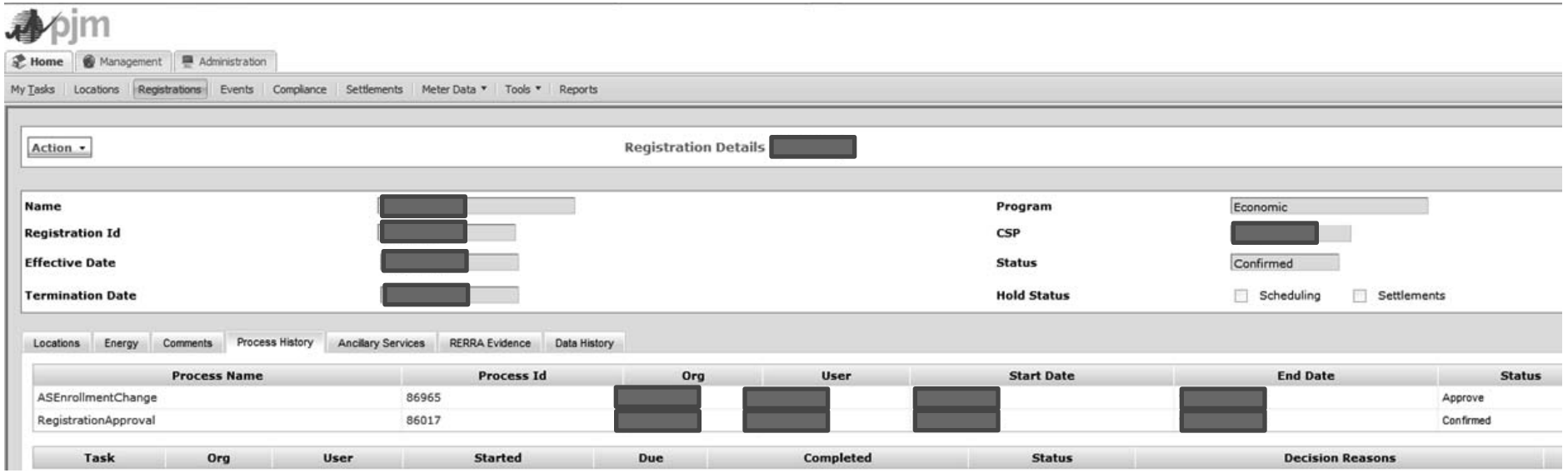
1. Under the Action button of the confirmed registration, select Request AS Enrollment Change

Request Regulation Participation in eLRS



2. Select Regulation

Request Regulation Participation in eLRS



3. A task is created for PJM to review the prerequisites for regulation participation
   - The task can be seen under the Process History tab with the process name of ASEnrollmentChange
   - The Status shows the results of the PJM review
     - Pending
     - Approved
     - Denied

Economic Regulation Only Registration

Economic Regulation Only (EconRegO) registration permits participation in regulation market only and is subject to all existing registration business rules except that the registration does not include the LSE or Pricing Point and therefore CSP locations may be aggregated by EDC by Transmission Zone. The LSE will not review this registration.

If CSP has an EconRegO registration then an Economic registration will only allow locations to participate in the energy market (Economic Energy Only) and they will not be permitted to participate in the SR or DASR market.

Request Economic Regulation Only Registration in eLRS

1. CSP to submit Econ Registration. Registration Name should start with "EconRegO_"
   a. CSP to designate LSE as EDC on registration and to use Pricing point for EDC
   b. CSP to "Submit CBL review" where reason is Other and Comment indicated "EconRegO registration and will only participate in Regulation market"
   c. CSP to submit registration
   d. PJM to approved CSP CBL review
   e. EDC/LSE to review
      i. If approved go to step 2 below
      ii. If EDC denies, CSP to go to CSP Review Denial Task, fix data where appropriate and then resubmit
      iii. If LSE denies, CSP to go CSP Review Denial Task and select Dispute. Include Comment – "Economic Regulation Only registration – no LSE review required"
         - PJM will approve registration if EDC has already approved

Note: *If registration has been approved by EDC and is waiting on LSE approval, CSP may contact PJM to expedite approval process. PJM will confirm registration since LSE is not required in review process*

Request Economic Regulation Only Registration in eLRS

2. If registration goes into duplicate status then PJM to allow or deny based on business rules.

3. Once registration is fully approved then CSP should select "Request AS Enrollment Change" and select Regulation. This will trigger PJM Regulation certification process.

4. All new AS requests (from approved Econ Registrations) must be checked to ensure there are no EconRegO for same location in effect. If there are then AS request should be rejected and note should be placed on Registration that Registration is EconEnergyOnly because same location is on EconRegO registration.

Prerequisites for Regulation Participation

Once Regulation participation is requested, a task is created in eLRS for PJM to coordinate the following prerequisites with the CSP:

1. The DSR resource must have a minimum regulation capability of 0.1 MW
   - 0.1 MW above basepoint and 0.1 MW below the basepoint
2. Provide PJM an overview of exactly how the locations in the registration will regulate
3. Complete mandatory Ancillary Service training using PJM LMS

Prerequisites for Regulation Participation

4. Complete all necessary telemetry & communication setup and testing
   a) Provide meter qualification form and associated meter qualification assurance plan. All metering must meet standards outlined in Manual 11 (section 10.6)
   b) Purchase and configure RTU (Director Box) for DNP3 data link to receive and transmit telemetry
      - List of independent contract resources that have assisted in the completion of Internet-based data links to PJM: http://www.pjm.com/planning/rtep-development/~/media/planning/rtep-dev/expan-plan-process/internet-dnp-data-link-resources.ashx
      - Document with FAQs on exchanging telemetered data with PJM: http://www.pjm.com/planning/rtep-development/~/media/planning/rtep-dev/expan-plan-process/pjm-telemetry-data-exchange-summary.ashx
      - Complete data link test

Prerequisites for Regulation Participation

c) Provide PJM 8 character name that identifies the resource to be included in telemetry

d) Determine if CSP would like to receive traditional or dynamic Reg signal

5. Pass PJM performance test as outlined in market rules described in Manual 12
6. CSP to provide telephone contact through ALL CALL form which will allow PJM dispatcher to contact CSP for any regulation specific communication
7. CSP must provide PJM Load Data that is not captured as part of the telemetry on an After the Fact basis (file transfer mechanism) as requested by PJM for Compliance validation. Such information will be at the location level to validate registration level load data submitted by CSP through telemetry

Prerequisites for Regulation Participation

Direction	Scope	Element	Abbrev.	Description
P → C	Registration	Regulation Assignment	AREG	The Regulation Assignment is the amount of regulation capability that PJM expects the resource to provide. Resource can self-schedule or elect to be pool-assigned by the market (SPREGO). Resources can also be assigned in real-time by PJM Dispatch.
C → P	Fleet	Total Regulation Capability	TREG	The regulating fleet determines the total real-time capability of all of its assigned resources, and reports this value to PJM.
P →C	Fleet	Regulation Signal	REGA, REGD	The EMS AGC determines the mismatch between supply and demand (RTO ACE) and generates a regulation signal for the fleet to follow. The traditional regulation signal (REGA) is suitable for slower, mechanical resources. The dynamic regulation signal (REGD) is suitable for faster, energy storage resources.
C → P	Registration	Power flow	NETMW (required), MW (optional)	PJM needs to observe the real-time energy that is injected or withdrawn by the locations on DR registration. A regulating resource will modulate its power generation or consumption to follow the regulation signal.
C→ P	Registration	Base-point	LOADBP	A resource provides regulation by adjusting its output with respect to the energy base-point. • Demand Response are expected to provide PJM with the MW value they are regulating around
C → P	Fleet	Regulation Compliance	CREG	Regulating Fleets can report their regulation compliance as a fleet calculation, as described in Manual 12. This value is the sum of [Power Flow] – [Base-Point] for all assigned units

A *Fleet* is a collection of *Registrations in a Control Zone*.

$\rightarrow\!\!\!\!\!/\,P$ *C* is PJM to Company, *C* $\rightarrow\!\!\!\!\!/\,P$ *is* Company to PJM

CSP Resources

- eLRS Users Guide – DR registrations and initiation of Regulation certification process
- eMkt User Guide – how to bid in regulation market
- DR Training material
- Ancillary Service Training material
- Historic Regulation Signal
- Key Manuals
  - M 11, section 3, 10
  - Manual 10, section 4
  - Manual 12

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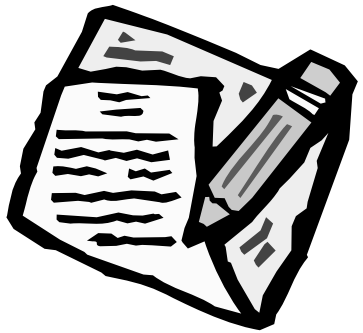


DR Regulation Participation through eMKT

- DR registrations do not need to be available for energy in order to participate in Regulation or Synchronized Reserves

- If a DR registration has offered in energy market (DSR Hourly Commit Status = Economic) then PJM will always take energy MW first and any residual MWs are then considered for SR or Reg

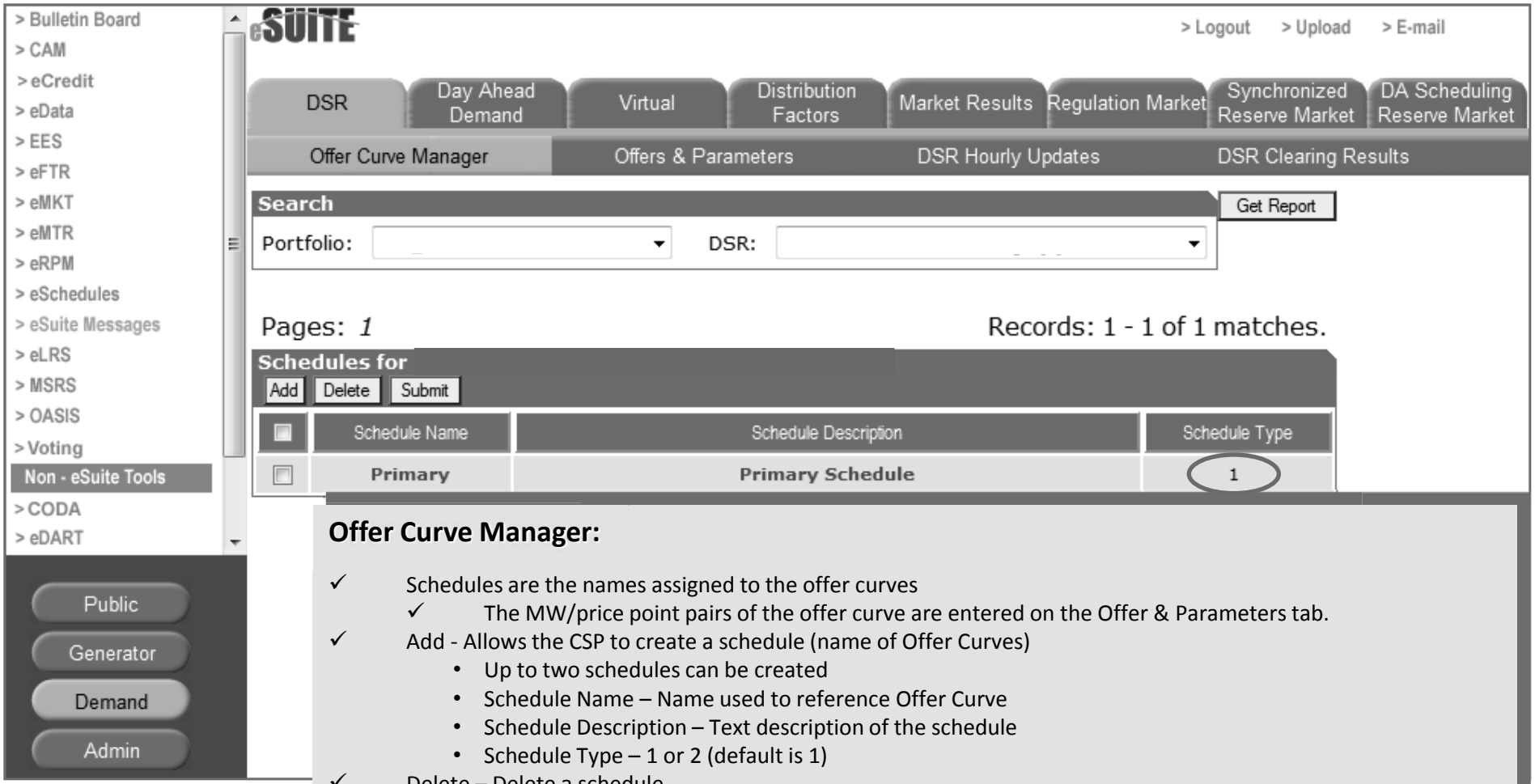
- If a DR registration is offered into both SR and Reg for same hour then PJM will take the lowest production cost offer

- If a DR registration self scheduled both SR and Reg for same hour PJM always take the regulation offer

- **The following pages in eMKT must be completed in order to clear or Self Schedule in the Regulation Market:**

Regulation Requires - Offer Curve Manager - Schedules

The Offer Curve Manager page is used in the Energy Market and is required for the Regulation Market



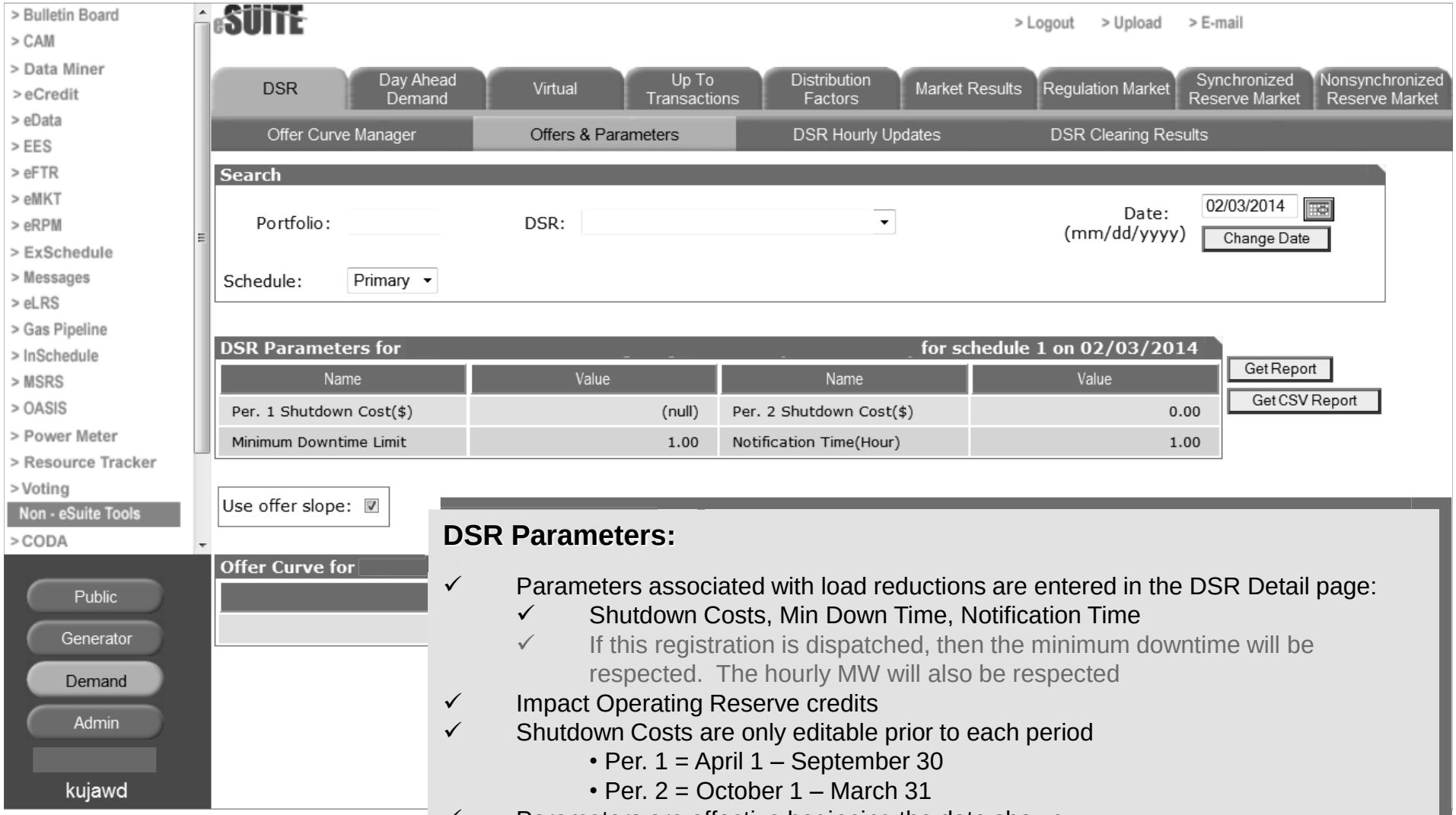
Offer Curve Manager:

- ✓ Schedules are the names assigned to the offer curves
  - ✓ The MW/price point pairs of the offer curve are entered on the Offer & Parameters tab.
- ✓ Add - Allows the CSP to create a schedule (name of Offer Curves)
  - Up to two schedules can be created
  - Schedule Name – Name used to reference Offer Curve
  - Schedule Description – Text description of the schedule
  - Schedule Type – 1 or 2 (default is 1)
- ✓ Delete – Delete a schedule
- ✓ Submit – Submit the results of adding or deleting a schedule
- ✓ Add, Delete or Submit is not permitted when market is closed

DSR Parameters and Offer Curve

DSR Offers and Parameters are used in the Energy Market

If DR resource does not participate in the energy market, then Offers and Parameters are not required



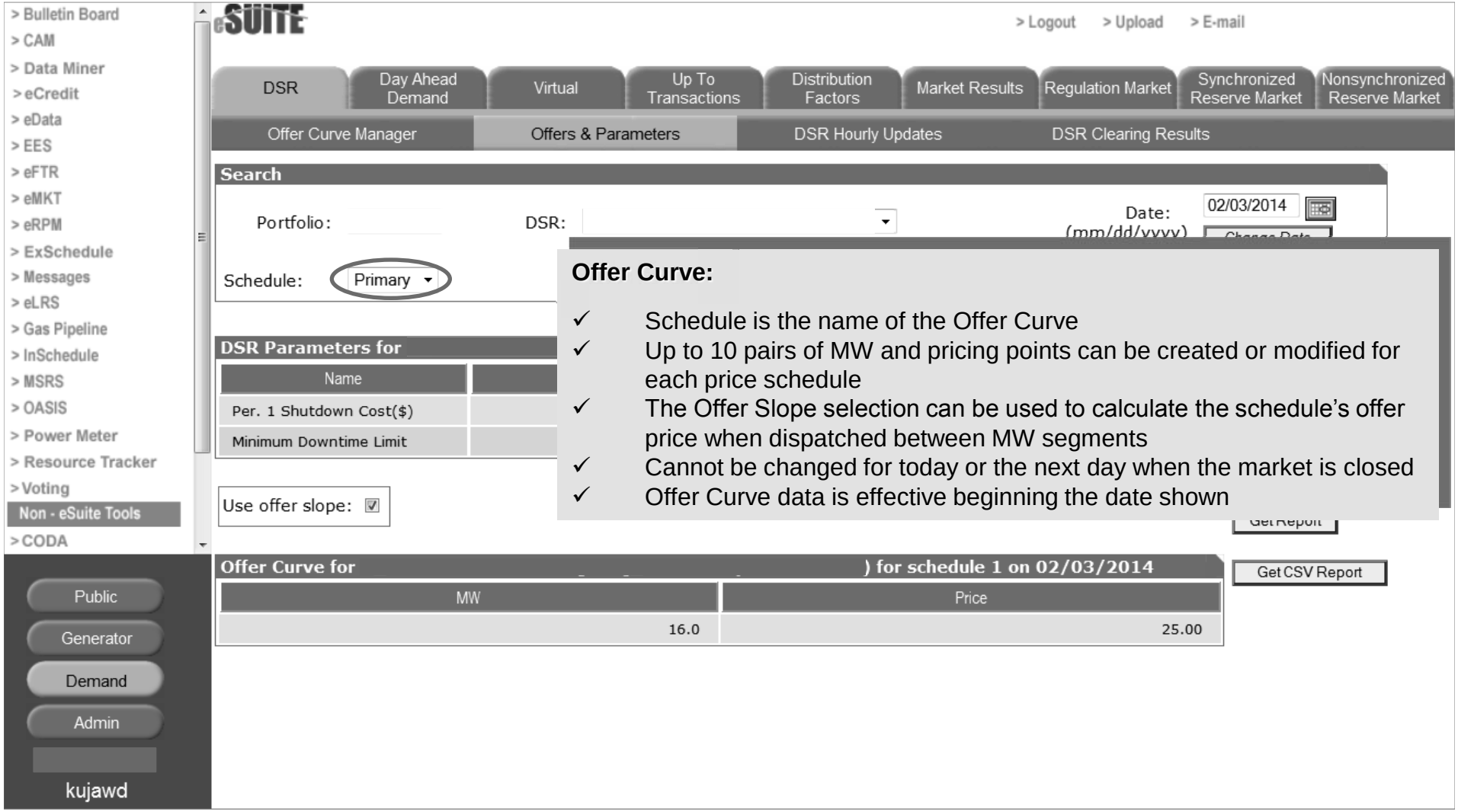
DSR Parameters:

- ✓ Parameters associated with load reductions are entered in the DSR Detail page:
  - ✓ Shutdown Costs, Min Down Time, Notification Time
  - ✓ If this registration is dispatched, then the minimum downtime will be respected. The hourly MW will also be respected
- ✓ Impact Operating Reserve credits
- ✓ Shutdown Costs are only editable prior to each period
  - Per. 1 = April 1 – September 30
  - Per. 2 = October 1 – March 31
- ✓ Parameters are effective beginning the date shown

DSR Parameters and Offer Curve

DSR Offers and Parameters are used in the Energy Market

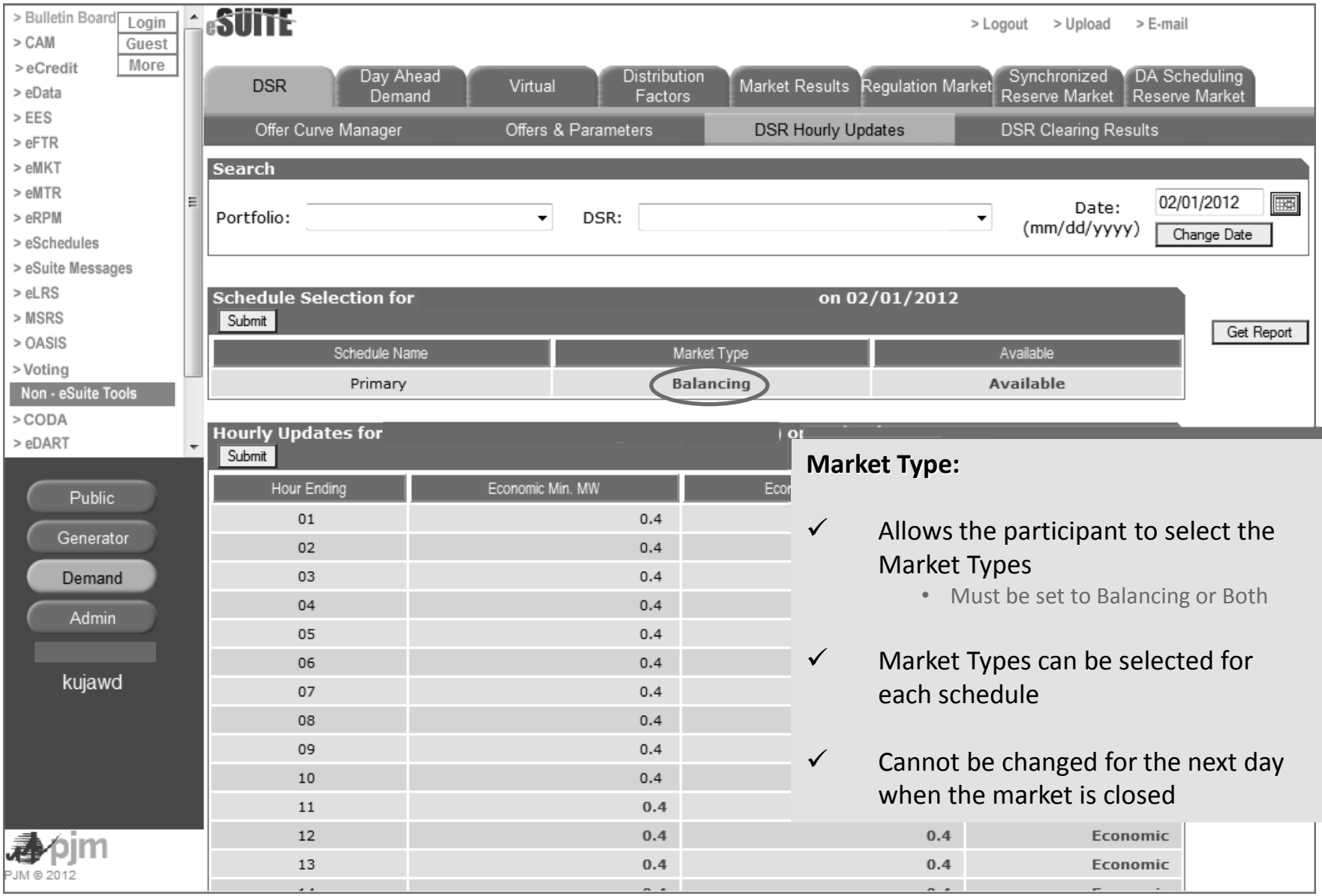
If DR resource does not participate in the energy market, then Offers and Parameters are not required



Regulation Requires - Schedule Selection and Hourly Updates

- The DSR Hourly Updates page contains the Schedule Selection which is used in the Energy Market and is **required for the Regulation Market**. The Schedule Selection defines the Market Type and availability used for economic participation. To participate in the Regulation Market, there must be one schedule available and the Market Type must be set to either "Balancing" or "Both"
  - Balancing – participate in the Balancing Market
  - Both – can participate in both the Day Ahead and Balancing Markets
    1. If hour clears in DA market then DR should respond with associated MWs. PJM will not dispatch in RT for hours that clear in DA market
    2. If hour does not clear then hour is eligible to be dispatched in RT

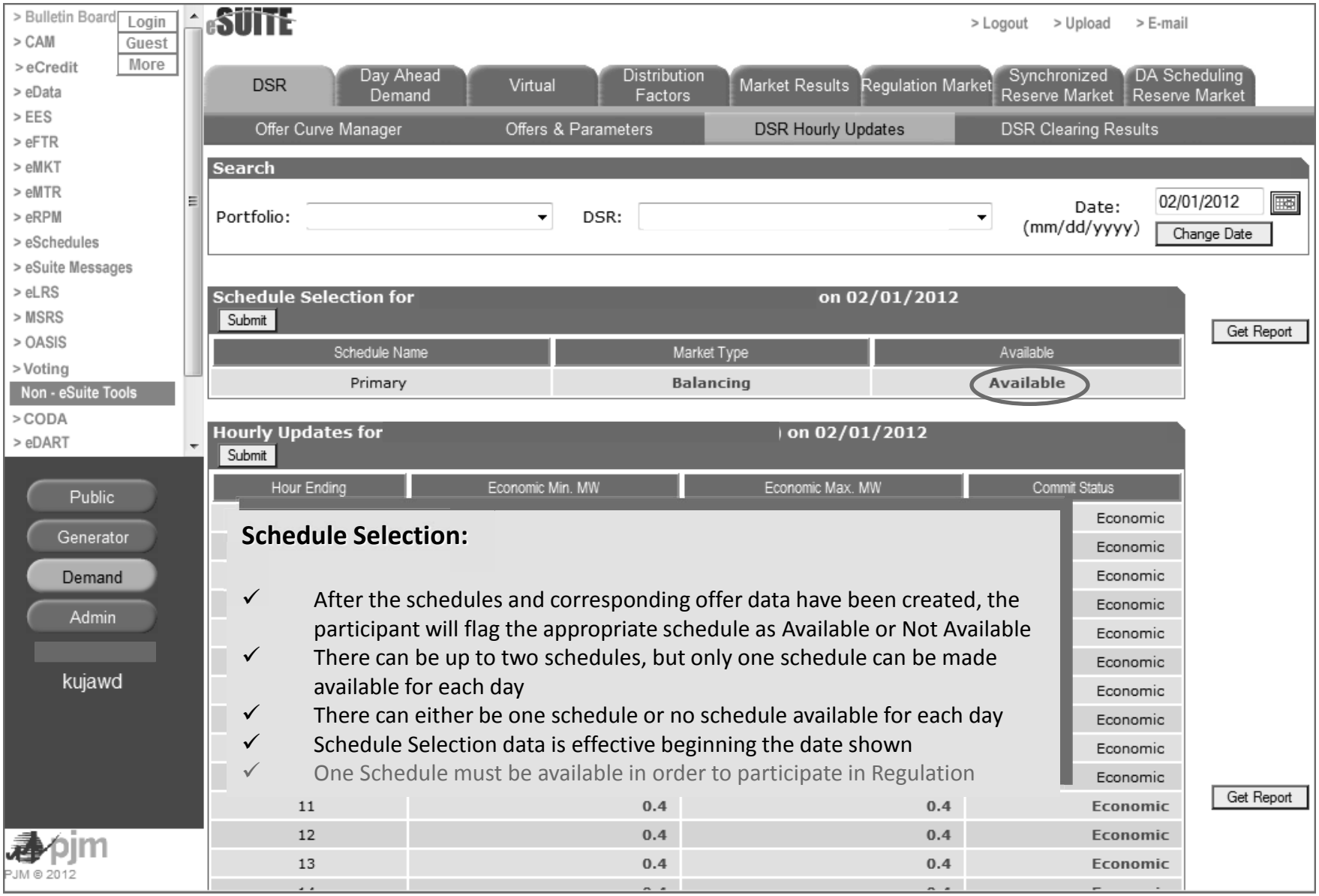
Regulation Requires - Schedule Selection and Hourly Updates



Market Type:

- ✓ Allows the participant to select the Market Types
  - Must be set to Balancing or Both
- ✓ Market Types can be selected for each schedule
- ✓ Cannot be changed for the next day when the market is closed

Regulation Requires - Schedule Selection and Hourly Updates



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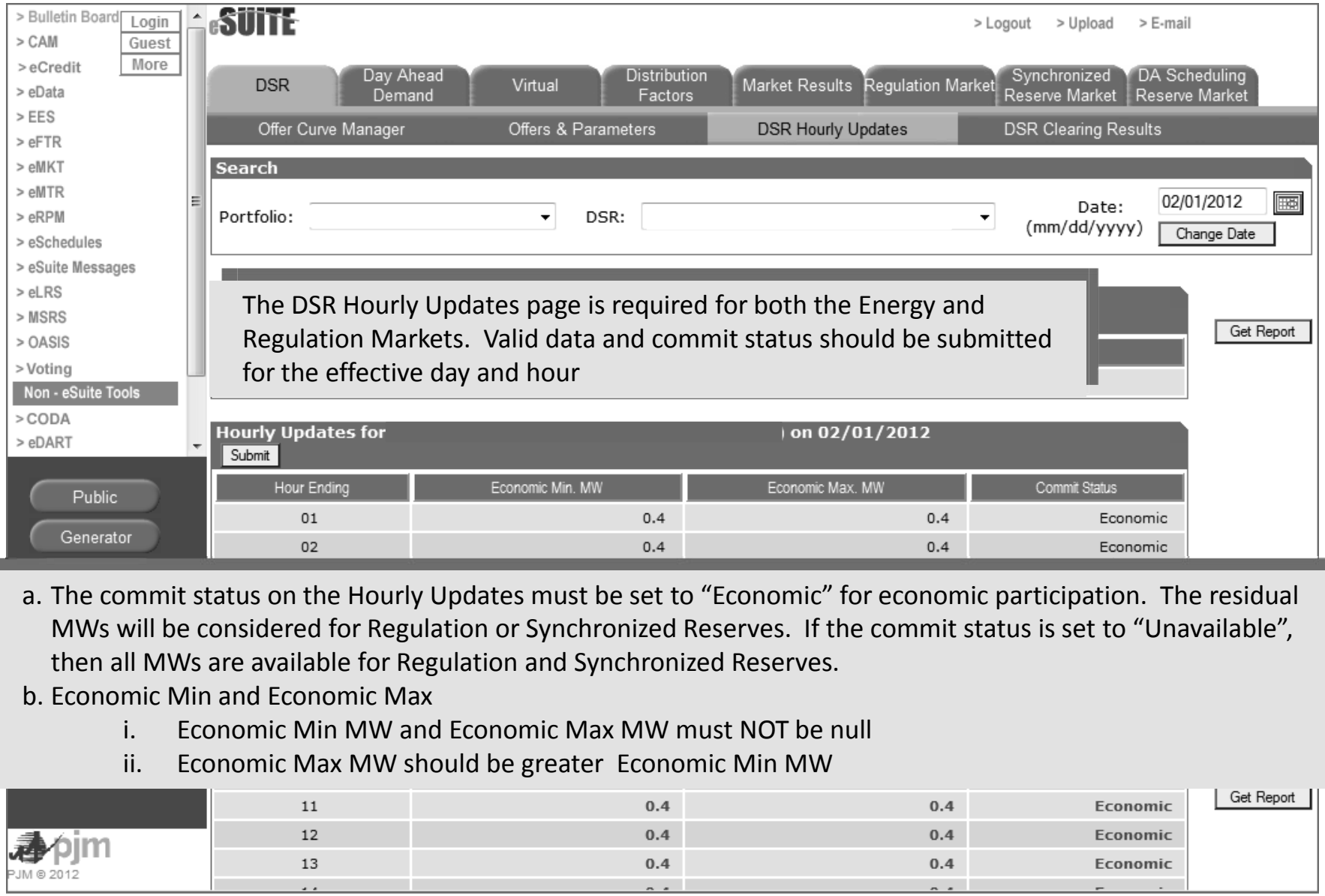


a. The commit status on the Hourly Updates must be set to "Economic" for economic participation. The residual MWs will be considered for Regulation or Synchronized Reserves. If the commit status is set to "Unavailable", then all MWs are available for Regulation and Synchronized Reserves.
b. Economic Min and Economic Max
    i. Economic Min MW and Economic Max MW must NOT be null
    ii. Economic Max MW should be greater Economic Min MW

Regulation Market – Regulation Offers

- A regulation enabled DSR resource may either offer economically or self-scheduled into the Regulation Market for a whole day on the "Regulation Market" – "Regulation Offers" page or do an hourly override on "Regulation Market" – "Regulation Updates" page
- **Note: Regulation Offers are automatically carried forward to the next unedited day**

Regulation Market – Regulation Offers

- **The following parameters are entered on the Regulation Offers page in eMkt:**
  1. Reg Type – Qualified resources may offer or bid MWs following RegA, RegD or both. This field will default to the resource owners units' qualified value
  2. Offer MW – The amount of regulation being offered above and below the regulation mid-point. Separate offers are made for RegA and RegD
  3. Price Offer – Cannot be more than $100/MW total
     1. Capability Offer Price – resource owner's price to reserve MWs for regulation in $/MW
     2. Performance Offer Price –resource owner's price to provide regulation movement in $/ Δ MW
  4. Cost Offer – Must meet Manual 15 Guidelines
     1. Capability Offer Cost – cost to reserve MW in $/MW, the values cannot be NULL (>=0). For those resources with costs not described in Manual 15 including DSR, may enter up to $12/MW margin adder for the cost offer. A Capability Offer Cost must be submitted in order for a DSR to clear for regulation either as self-scheduled or economic
     2. Performance Offer Cost – cost to move MW in $/ Δ MW. Not defined for DSR and therefore, the Performance Offer Cost for a DSR resources is $0/MWh or null

Regulation Market – Regulation Offers cont'

- **The following parameters are entered on the Regulation Offers page in eMkt:**
  5. Reg Min MW – The minimum regulation MW
  6. Reg Max MW – The maximum regulation MW. Reg Max MW must be greater than Reg Min MW. (**Reg Max MW – Reg Min MW) must result in a positive number**
  7. Min MW – The minimum regulation assignment. The marginal regulation resources may clear at a value less than the Offer MW. PJM will not clear a regulation resource less than the Min MW value If marginal regulation unit is less than the Min MW, then that resource is bypassed and the next resource is be considered
  8. Available Status – The daily status of the regulation resource is either Available or Unavailable. Hourly status is entered on the Regulation Update page
  9. Self Scheduled – Select Self Scheduled to self schedule a DSR resource for regulation
  10. Rolling Ave. Performance Score – is the rolling average of the last 100 hours of operations or a weighted average of the average of the three initial or requalification scores that are then averaged with available actual hourly performance scores

Regulation Market – Regulation Updates

Entries in the Regulation Updates page will override entries on the Regulation Offers page for the hour ending. **The deadline for entering the Regulating Updates is 60 minutes prior to the beginning of the desired operating hour ending. For example, a Regulation Update for hour ending 15 must be made by 13:00 (beginning of hour ending 14)**

Daily Offer MW cannot be zero, but hourly updates can be set to zero to override the daily offer. For example, a CSP places a Regulation Offer for a DR resource effective on a particular date, but does not wish to participate in every hour. In that case, the "Available Status" on the Regulation Updates page must be set to "Not Available" and the MW value must be set to 0 for the applicable hours

Note: Regulation Updates are NOT automatically carried forward to the next unedited day

Regulation Updates for

Hour Ending	Regulation Min MW	Regulation Max MW	Reg A MW	Reg A Self Scheduled	Reg A Available Status	Reg D MW	Reg D Self Scheduled	Reg D Available Status
01	(null)	(null)	(null)	-	Available	(null)	-	Available
02	(null)	(null)	(null)	-	Available	(null)	-	Available
03	(null)	(null)	(null)	-	Available	(null)	-	Available
04	(null)	(null)	(null)	-	Available	(null)	-	Available
05	(null)	(null)	(null)	-	Available	(null)	-	Available
06	(null)	(null)	(null)	-	Available	(null)	-	Available
07	(null)	(null)	(null)	-	Available	(null)	-	Available
08	(null)	(null)	(null)	-	Available	(null)	-	Available
09	(null)	(null)	(null)	-	Available	(null)	-	Available
10	(null)	(null)	(null)	-	Available	(null)	-	Available
11	(null)	(null)	(null)	-	Available	(null)	-	Available
12	(null)	(null)	(null)	-	Available	(null)	-	Available

Regulation Market Offer Constraints

1. The minimum offer MW for any resource to clear either as economic and/or as self-scheduled in Regulation and/or Synchronized Reserve Market is 0.1 MW

2. The minimum offer MW increment for any resource as currently designed in eMKT is 0.1 MW. That is, eMKT will NOT accept offer MW to 2 decimal places. If the CSP attempts to enter a MW value that has more than one decimal place, then eMKT will round offer MW to either 1 decimal place or to a whole number

3. Offer MW cannot be negative

4. Offer MW can be null

Regulation Market Results

Location	Reg A Offer MW	Reg D Offer MW	Tier-2 Offer MW	Self-Sched MW	Tier-2 MW	Reg A MW	Reg D MW	Reg TPS Result	Reg Offer Price Used	Actual Hourly Performance Score
	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.00	
	0.0	0.1	0.0	0.1	0.0	0.0	0.0	PASS	0.00	
	0.0	0.8	0.0	0.8	0.0	0.0	0.0	PASS	0.00	

Regulation assignments posted
30 minutes prior to the hour

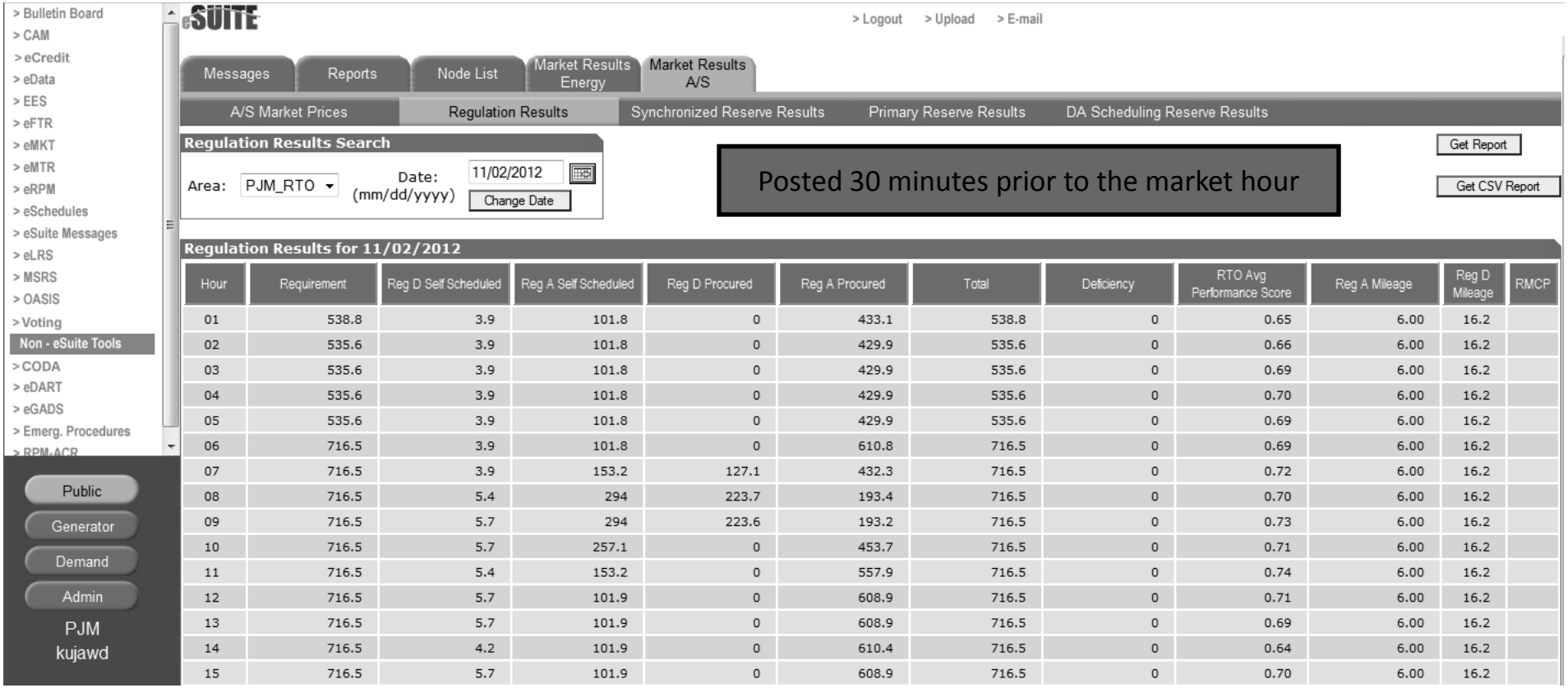
Ancillary Service Market Prices

Real Time Hourly LMP Values for 20121102												
Start of Ancillary Service MCP Data	100	200	300	400	500	600	700	800	900	1000	1100	1200
RTO Regulation Performance	9.61	11.99	8.79	8.69	11.76	12.84	9.7	7.15	5.24	9.9	6.51	8.59
RTO Regulation Capability	25.92	13.78	20.49	14.43	27.15	28.07	33.13	45.38	18.51	32.56	52.44	41.71
RTO Marginal Benefits Factor	1	1	1	1	1	1	1	1	1	1	1	1
RTO Non-Synchronized Reserve	0	0	0	0	0	0	0	0	0	0	0	0
RTO Synchronized Reserve	0	0	0	0	0	0	0	0	0	0	0	0
MAD Non-Synchronized Reserve	0	0	0	0	0	0	0	5.78	0.08	3.29	13.45	0
MAD Synchronized Reserve	0	0	0	0	0	0	0	5.78	0.08	3.29	13.45	0
End of Ancillary Service MCP Data												

Regulation, Synchronized Reserve and Non-Synchronized Reserve Market Clearing Prices (MCPs) are posted with the Daily Real-Time LMP Files

Ancillary Services Market Clearing Prices are posted for hours ending 100 through hours ending 2400

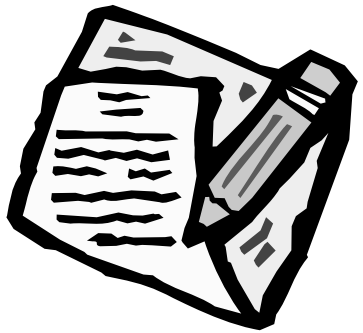
Regulation Market Results



Hour	Requirement	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	RMCP
01	538.8	3.9	101.8	0	433.1	538.8	0	0.65	6.00	16.2	
02	535.6	3.9	101.8	0	429.9	535.6	0	0.66	6.00	16.2	
03	535.6	3.9	101.8	0	429.9	535.6	0	0.69	6.00	16.2	
04	535.6	3.9	101.8	0	429.9	535.6	0	0.70	6.00	16.2	
05	535.6	3.9	101.8	0	429.9	535.6	0	0.69	6.00	16.2	
06	716.5	3.9	101.8	0	610.8	716.5	0	0.69	6.00	16.2	
07	716.5	3.9	153.2	127.1	432.3	716.5	0	0.72	6.00	16.2	
08	716.5	5.4	294	223.7	193.4	716.5	0	0.70	6.00	16.2	
09	716.5	5.7	294	223.6	193.2	716.5	0	0.73	6.00	16.2	
10	716.5	5.7	257.1	0	453.7	716.5	0	0.71	6.00	16.2	
11	716.5	5.4	153.2	0	557.9	716.5	0	0.74	6.00	16.2	
12	716.5	5.7	101.9	0	608.9	716.5	0	0.71	6.00	16.2	
13	716.5	5.7	101.9	0	608.9	716.5	0	0.69	6.00	16.2	
14	716.5	4.2	101.9	0	610.4	716.5	0	0.64	6.00	16.2	
15	716.5	5.7	101.9	0	608.9	716.5	0	0.70	6.00	16.2	

Agenda

- **Market-based Regulation**
  - Market-based Regulation Overview
  - Request Regulation Participation in eLRS
  - Regulation Participation through eMKT
  - **Regulation Performance and Settlements**
  - Performance Groups
  - Regulation Load Data Retention Guidelines
- Synchronized Reserve Market
- Day Ahead Scheduling Reserve Market



Performance Scores

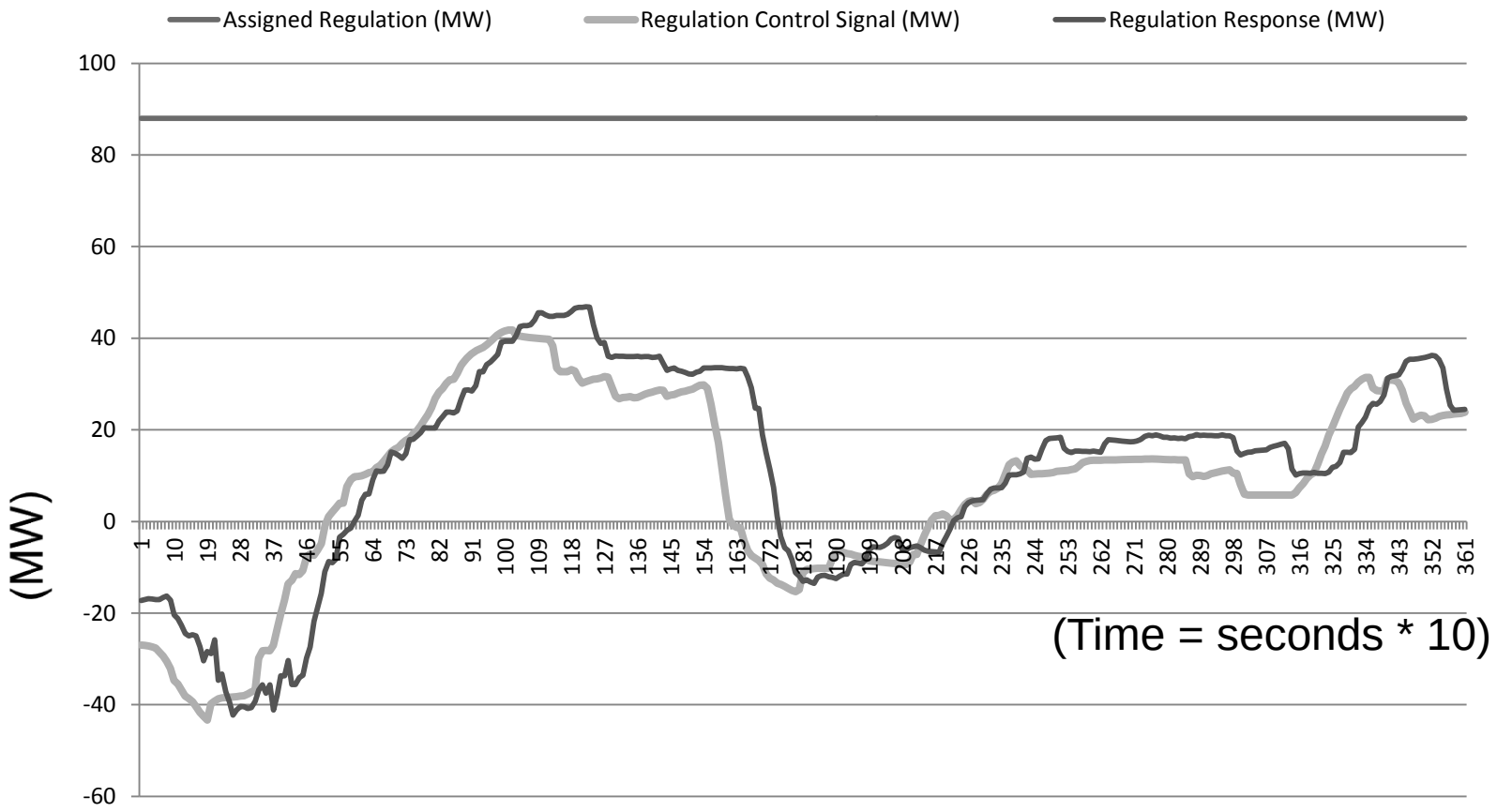
Calculate a performance score for each regulation resource for each regulating hour

- Performance scores reflect the benefits each resource provides to system control by focusing on the resource's response to our control signals
- Provide continuous feedback to the regulation resources of their performance using near real time reporting
- Data posting for each resource through eMKT

Performance Score – 3 pieces

- 1) Accuracy – the correlation or degree of relationship between control signal and regulating unit's response
  - 5 minute rolling correlation with 10 second granularity
  - Re-calculated with a 10 second time shift up to 5 minutes
- 2) Delay – the time delay between control signal and point of highest correlation from Step 1
  - Over a 5 minute period with a 10 second propagation delay
- 3) Precision – Difference between the areas under the curve for the control signal and the regulating unit's response
- Composite Performance Score = A [ScoreA] + B [ScoreD] + C [ScoreP]
  - A, B, C are scalars from [0..1], total to 1
  - Produces a weighted average of component scores

Performance Score Example



Correlation: 0.95 Delay: 0.66 Precision: 0.74

Total Performance Score: 0.78

Rolling 100 Average Performance Score

The Rolling 100 Hour Average Performance Score takes the average of all the performance scores for the last 100

eMKT – Hourly Score

DSR | Day Ahead Demand | Virtual | Up To Transactions | Distribution Factors | Market Results | Regulation Market | Synchronized Reserve Market | Nonsynchronized Reserve Market | DA Scheduling Reserve Market | PRD

Demand Market Results | Regulation and Reserve Award | DA Scheduling Reserve Award

Search

Portfolio: DSR: Hour: 15 Date: (mm/dd/yyyy) 11/02/2012 Change Date

Get Report

Get CSV Report

Pages: *1*

Records: 1 - 3 of 3 matches.

Regulation and Reserve Award for ALL LOCATIONS on 11/02/2012

Location	Reg A Offer MW	Reg D Offer MW	Tier-2 Offer MW	Self-Sched MW	Tier-2 MW	Reg A MW	Reg D MW	Reg TPS Result	Reg Offer Price Used	Actual Hourly Performance Score
	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.00	
	0.0	0.1	0.0	0.1	0.0	0.0	0.0	PASS	0.00	
	0.0	0.8	0.0	0.8	0.0	0.0	0.0	PASS	0.00	

The Actual Average Hourly Performance Score is calculated for each hour by the Performance Score Calculation Engine (PSCE) and displayed each hour in eMKT

Payment for Performance

If DSR Performance Score < .25, then

- DSR RMCCP Credit = 0
- DSR RMPCP Credit = 0
- DSR Reg Lost Opportunity Cost Credit = 0

If DSR Performance Score >= .25, then

- DSR RMCCP Credit = (DSR PJM-Assigned Reg + DSR Self-Scheduled Reg) * DSR Performance Score * RMCCP
- DSR RMPCP Credit = (DSR PJM-Assigned Reg + DSR Self-Scheduled Reg) * DSR Mileage Ratio * DSR Performance Score * RMPCP
- DSR Reg Lost Opportunity Cost Credit = MAX(DSR Reg Offer Amount - (DSR PJM-Assigned Reg * DSR Performance Score * RMCCP) – (DSR PJM-Assigned Reg * DSR Performance Score * DSR Mileage Ratio * RMPCP),0)

Note:

Mileage is the summation of movement requested by the regulation control signal a resource is following. It is calculated for the duration of the market hour for each regulation control signal (i.e. RegA and RegD).

Thresholds, Disqualification and Requalification

- Regulating resources that have not met performance thresholds
  - Resources are disqualified and must re-qualify to offer into the regulation market
  - Disqualification threshold is based on a 100 hour rolling average with an average performance score below 40%
  - When a regulating resource falls below the threshold, the owner will be notified, and the resource will no longer be able to offer
  - Upon successful completion of requalification, the resource will begin a new rolling average with no hours from the previous low-performing period
- The performance score calculation (PSC) is near real-time and automatic
  - Each resource is evaluated with a PSC for each hour of regulation
  - Resources with a PSC of 25% or lower do not receive a regulation credit or LOC for that hour

Agenda

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  - **Performance Groups**
  - Regulation Load Data Retention Guidelines
- Synchronized Reserve Market
- Day Ahead Scheduling Reserve Market

Performance Groups

Performance Groups can be created for the purpose of calculating an aggregate performance score for the resources that are in the Performance Group.

Individual resources will still offer into the market with their own bids, and will provide individual response telemetry. The assignments and telemetry are aggregated to the group, and the group is scored as if it were a single resource.

Performance Score

- Performance Score is generated at the Performance Group level, using Performance Group Response against the Performance Group signal
- Members of a Performance Group are scored at the group level, but settled at the resource-level . Performance Group Score is copied down to all resources in the group for resources that have a non-zero assignment
- Settlements are calculated based on individual resource performance

Performance Groups

Performance groups can only be created for resources that satisfy one of the following criteria:

1. Resources not eligible for LOC and total to less than or equal to 10 MWs across Transmission Owner boundaries.
   - **DR and batteries are not eligible for LOC**
   - **Resource owners can create Performance Groups totaling less than or equal to 10 MW with resources in more than than zone**
2. A performance group can be any number of resources not eligible for LOC inside a transmission owner's boundary.
   - **DR and batteries are not eligible for LOC**
   - **Resource owners can create Performance Groups with any number of resources within a single zone**
3. Resources within a fleet with equivalent applicable offers and point of interconnection.
   - **Electrically equivalent and connected to the same LMP pricing point**
   - **Equal regulation offer prices and costs**

Creating Performance Groups

- Resource owners will notify PJM via RegulationTesting@pjm.com that they satisfy one of the Performance Group criteria.
- Performance Groups need to be set up prior to use
  - Cannot be set up after-the-fact
- Documentation must be sent to the PJM Performance Compliance Department if there are to be any future modifications to the Performance Group
  - Additions or deletions of resources
- Resources that are part of a performance group will send the Operational Midpoints for the grouped resources by signal type (REGA or REGD). Each resource will be metered independently.
  - Operational Midpoint (LOADBP) – the point around which the regulating resource (unit, plant or registration) operates.
    - LOADBP is sent to PJM through a DNP point
    - The **maximum** number of times that LOADBP can be changed is **once every 15 minutes**

Offers, Assignments and Response for Demand Resources

- CSP bids at the registration level
- Assignments are made by the market (clearing) at the registration level
- Registration assignments are summed to a Performance Group
- Performance Group assignment is then used to generate a Performance Group signal = (REGA or REGD) * (Performance Group Assignment / (TREGA or TREGD))
- Response is given at a registration level
  - Registration response is summed to a Performance Group response over all registrations with a non-zero assignment

Performance Group Example

Performance Group 1			Performance Group 2		
	AREG (REGA Assigned MW)	Qualified Regulation Capability (MW)		AREG (REGD Assigned MW)	Qualified Regulation Capability (MW)
Resource 1	1	2	Resource 4	0.7	1
Resource 2	0.1	0.1	Resource 5	3	4
Resource 3	0.2	0.2	Resource 6	0	1
Total	**1.3**	**2.3**	**Total**	**3.7**	**6**

- Performance Groups contain resources with the same resource type
  - REGA or REGD
- Under performing resources may be covered by over performing resources within a Performance Group
- Performance Group signal = (REGA or REGD) * (Performance Group Assignment / TREGA or TREGD)
- TREGA = 1.3
- TREGD = 3.7

Performance Group Example – cont.

Performance Group 1			Performance Group 2		
	AREG (REGA Assigned MW)	Qualified Regulation Capability (MW)		AREG (REGD Assigned MW)	Qualified Regulation Capability (MW)
Resource 1	1	2	Resource 4	0.7	1
Resource 2	0.1	0.1	Resource 5	3	4
Resource 3	0.2	0.2	Resource 6	0	1
Total	**1.3**	**2.3**	**Total**	**3.7**	**6**

- Resource 6 cannot participate in Performance Group 2 since it was not assigned regulation for that hour
- Resource performance within the Performance Group is bounded by the resource's market assignment
- If the regulation signal (REGA or REGD) of the Performance Group is not at full raise or full lower then resources within the group may over perform up to their assigned regulation to compensate for the underperforming resources
  - For example, PG 1 assign regulation is 1.3 MW and gets a signal of -0.6 MW. The regulation can be distributed among all three resources with each limited by the assigned regulation
  - Resource 1 can provide -0.6 and Resources 2 and 3 can provide 0 MW

Performance Group Example – cont.

Performance Group 1			Performance Group 2		
	AREG (REGA Assigned MW)	Qualified Regulation Capability (MW)		AREG (REGD Assigned MW)	Qualified Regulation Capability (MW)
Resource 1	1	2	Resource 4	0.7	1
Resource 2	0.1	0.1	Resource 5	3	4
Resource 3	0.2	0.2	Resource 6	0	1
Total	**1.3**	**2.3**	**Total**	**3.7**	**6**

- The Performance Group score is calculated as the aggregate response of the members of the Performance Groups, based on individual assignments, versus the group's regulation signal
- Energy and ancillary services settlements are created for all individual resources in the Performance Groups

Agenda

- **Market-based Regulation**
  - Market-based Regulation Overview
  - Request Regulation Participation in eLRS
  - Regulation Participation through eMKT
  - Regulation Performance and Settlements
  - Performance Groups
  - **Regulation Load Data Retention Guidelines**
- Synchronized Reserve Market
- Day Ahead Scheduling Reserve Market

CSP Regulation Load Data Retention Guidelines

- CSP should determine load data retention period that is adequate to ensure load data is available for any potential settlement or compliance issues
  - For example, if there was telemetry failure and load data was not sent then PJM will assume service was not provided during that period unless load data is provided to PJM at later date from archive
- PJM minimum load data retention guidelines for audit purposes
  - Sub-metered device (if approved by PJM in accordance with M-11 requirements)
    - The approved sub-meter should record power measurements (Watts) at the same interval as the Regulation signal telemetry (typically 2-4 seconds)
    - Data for each device tied to a specific Location should be retained by CSP for 3 months

PJM should be able to sum up individual sub meter load data for all locations on registration to get to registration level (aggregate) load data submitted through telemetry.

CSP Regulation Load Data Retention Guidelines

- PJM minimum load data retention guidelines for audit purposes
  - eLRS Location
    - Load data at location level (EDC meter, or CSP approved meter), should be available upon request by PJM at the most granular level available to the CSP but no greater than 1 hour.
      - PJM expects to only request data that is up to 3 months old
      - PJM will work with CSP on specifics (including timing) during the request process.
      - Intention is to not require new set of metering at location level.

  PJM should be able to compare location level load data for subset of locations with device level load data at same locations for reasonability test.

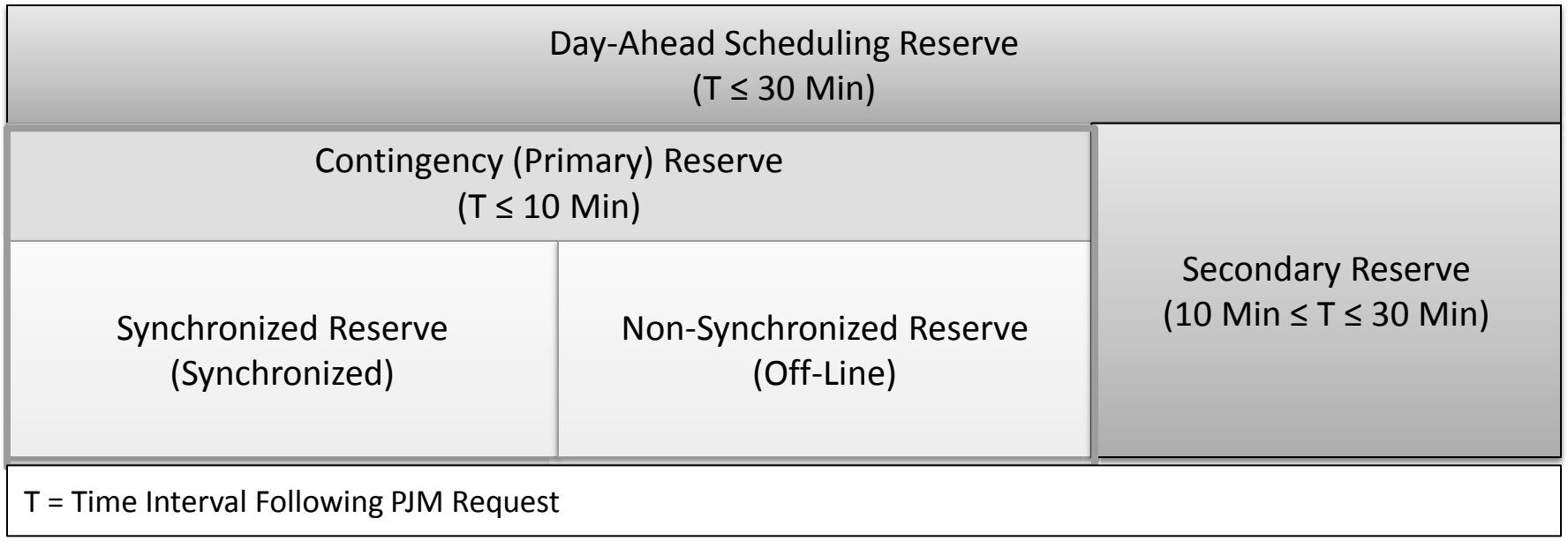
  - eLRS Registration
    - The aggregate load data of all sub-metered devices should be available at the same interval as the Regulation signal telemetry
    - Data should be retained by CSP for 6 months.

Agenda

- Regulation Market
- **Synchronized Reserve Market**
  - **Market-based Synchronized Reserve Overview**
  - Demand Response Requirements
  - Request SR Participation in eLRS
  - SR Participation through eMKT
  - SR Monitoring and Verification
  - SR Financial Compensation and Penalties
- Day Ahead Scheduling Reserve Market

Reserves

- Reserves are additional generation capacity above the expected load. Scheduling excess capacity protects the power system against the uncertain occurrence of future operating events, including the loss of energy or load forecasting errors



Reserve Zone Structure

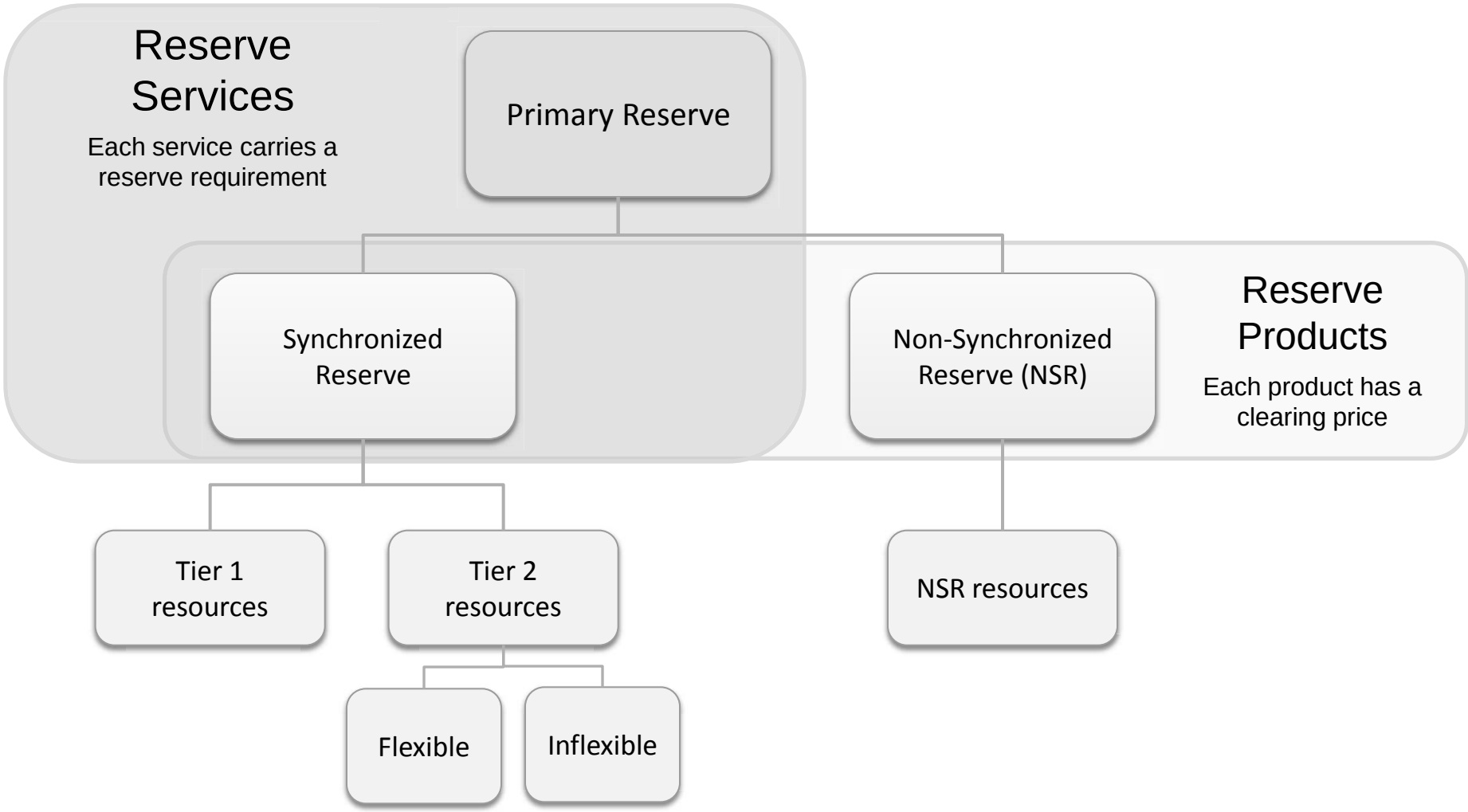
- PJM Reserve Market has one Reserve Zone and one sub-zone
  - RTO Reserve Zone
  - Mid-Atlantic and Dominion (MAD) Sub-zone
- The MAD sub-zone is defined in the Reserve Market to ensure that reserves are available in or deliverable to the eastern part of the system under constrained conditions. The MAD sub-zone is defined by the most limiting monitored transfer interfaces
  - Resources with a 3% or greater raise help distribution factor on the interface are included in the MAD sub-zone
- When most limiting monitored transfer interfaces reaches the thermal limit:
  - MAD Sub-Zone will have a locational requirement

Reserve Zone Definitions

Zones that are Always located in MAD	Zones that are Never located in MAD	Zones with specific buses that may be Located in MAD
PS, PE, PL, BC, JC, ME, PEP, AE, DPL, RECO	DEOK, CE, DAY, DUQ, ATSI, EKPC	PN, AP, AEP, DOM

- The MAD sub-zone Bus and Resource list is posted on the PJM website at: http://www.pjm.com/markets-and-operations/ancillary-services/synchronized-service.aspx
- Busses not located in the MAD sub-zone considered to be in the RTO

Reserve Markets



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

Primary Reserve Resource Types

Tier 1 (Economic)	Online units that are following economic dispatch and only partially loaded and therefore are able to increase output within 10 minutes following PJM dispatcher request to an event
Tier 2 (Non-Economic)	Resources that offered into the Synchronized Reserve Market and cleared • Condensers (CTs and hydro) transition to online Tier2 condense mode • Steam reduced to provide Tier2 MW, • CTs online at min – operating at a point that deviates from economic dispatch, • Demand Response that can drop load
10 minute Non-Synchronized Reserve	Resources currently not synchronized to the grid • Shutdown run-of-river hydro, • Shutdown pumped hydro, • Offline industrial combustion turbines, jet engine/expander turbines, etc

Flexible vs. Inflexible Resource Designation in Tier2 SR

Flexible

Resources:

- Online generators following economic dispatch and can be backed down for Tier2
- **Tier2 Demand Response**

Attributes:

- Can respond immediately to real-time 5-minute commitment

Ability to receive Tier 2 commitment via approved telemetry (Director Box with New Technology)

Inflexible

Resources:

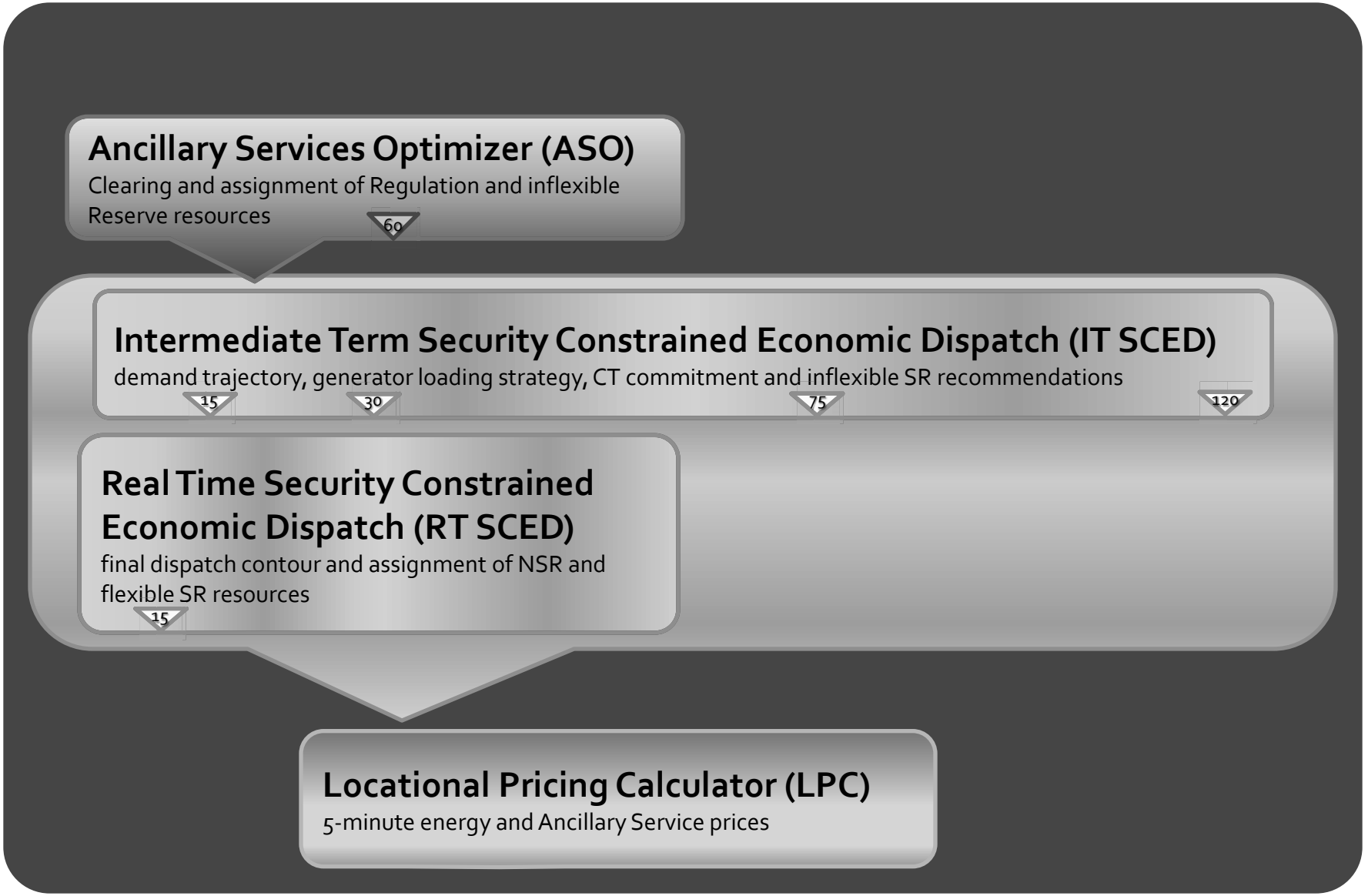
- Synchronous condensers that can be committed for Tier2 from offline state
- **Tier2 Demand Response**

Have limiting parameters

For example:

- minimum run time of 1 hour
- notification/lead time of at least 30 minutes

Tier2 commitment notifies via eMKT


Ancillary Services Optimizer (ASO)
Clearing and assignment of Regulation and inflexible Reserve resources
60
Intermediate Term Security Constrained Economic Dispatch (IT SCED)
demand trajectory, generator loading strategy, CT commitment and inflexible SR recommendations
15
30
75
120
Real Time Security Constrained Economic Dispatch (RT SCED)
final dispatch contour and assignment of NSR and flexible SR resources
15
Locational Pricing Calculator (LPC)
5-minute energy and Ancillary Service prices

Primary Reserve Requirement

- The Primary Reserve Requirement is defined as the amount of 10-minute reserve (synchronized or off-line) that must be available
  - Inclusive of the Synchronized Reserve requirement
- May be met with Tier 1, Tier 2 resources and NSR Resources
- RTO reserve zone requirement will be the greater of:
  - Calculated RFC minimum requirement OR
  - 150% of the largest contingency in the PJM footprint
    - Usually 2000 MW
- Mid-Atlantic Dominion sub-zone requirement will be equal to 150% of the largest contingency in Mid-Atlantic Dominion region
    - Usually 1700 MW
    - Any reserves committed in the Dominion zone will be used to meet the 433 MW VACAR Reserve Sharing Group (RSG) commitment

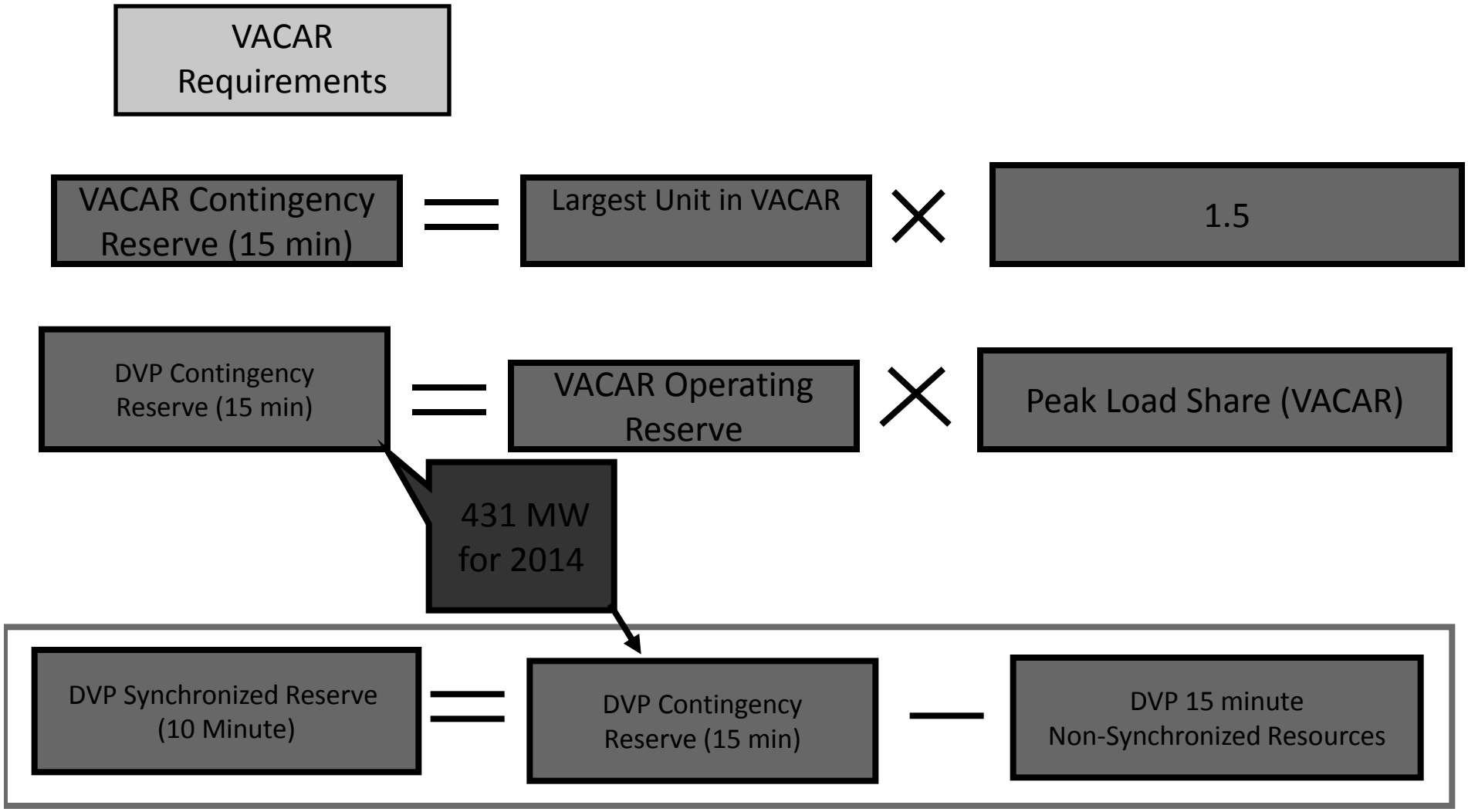
Of the 2000 MW RTO reserve zone requirement,
1700 MW must be deliverable to the Mid-Atlantic Dominion sub-zone

Synchronized Reserve Requirement

- The Synchronized Reserve Requirement is defined as the amount of 10-minute reserve that must be synchronized to the grid
- May be met with Tier 1 or Tier 2 resources
- RTO reserve zone requirement will be the greater of:
  - Calculated RFC minimum requirement OR
  - Largest contingency in RTO Synchronized Reserve Zone
    - Usually 1350 MW
- Mid-Atlantic Dominion sub-zone requirement will be equal to largest contingency in the Mid-Atlantic Dominion region
    - Usually 1300 MW
    - Any reserves committed in the Dominion zone will be used to meet the 433 MW VACAR Reserve Sharing Group (RSG) commitment

Of the 1350 MW RTO reserve zone requirement,
1300 MW must be deliverable to the Mid-Atlantic Dominion sub-zone

Dominion Reserve Requirement



Reserve Markets and Product Substitution

- Synchronized Reserve Market
  - One market for each region if there are transmission constraints
  - Synchronized Reserves in MAD can be used to satisfy the RTO requirement (locational substitution)
  - Historically, very few hours when RTO Synch Reserve Market cleared with non-zero price
  - Price is always greater than or equal to the Non-Synchronized Reserve Price
- Non-Synchronized Reserve Market
  - Used to procure the balance of the Primary Reserve requirement that is not being met with Synch Reserve
  - Synch Reserve can be used in place of Non-Synch Reserve to meet the Primary Reserve requirement (product substitution)
  - Non-Synch Reserves in MAD can be used to satisfy the RTO Primary Reserve requirement (locational substitution)
  - Price is expected to be zero except when the system is getting shorter on reserves
  - Price is always less than or equal to the Synch Reserve price
  - **Demand Resources may not participate as NSR resources**

Synchronized Market Operation

PJM Dispatch call the Synchronized Reserve Events. The CSP is notified of the Synchronized Reserve Event via Electronic Notification and the PJM All-Call.

- Electronic Notification is a requirement and is the primary means of Synchronized Reserve notification
- PJM All-Call is a requirement and is an additional means of Synchronized Reserve notification
  - Used as confirmation for the Electronic Notification
- The CSP, without regard to price and as quickly as possible, implement the requested percentage of Synchronized Reserve
- Continue to implement Synchronized Reserve until directed by PJM dispatcher to discontinue
- The official event start time of the Synchronized Reserve Event is determined after-the-fact

Electronic Notification

Requirement: It is a requirement for CSPs to receive Electronic Notification for Emergency DR, real-time dispatch and Synchronized Reserve Events.

Objective: To communicate with CSPs, via eLRS web service functions, their Load Management, RT dispatch and Synchronized Reserve instructions and confirm that the instructions have been received.

Events

- When PJM calls Load Management, RT Dispatch or Synchronized Reserve events, information needs to be pulled from eLRS by the CSP via periodic polling.

Electronic Notification Polling requirements

- Polling is done by CSP (organization)
  - If CSP has more than one ORG with registrations, then they must poll each ORG separately
- At each CSP/ORG there should only be one userid performing the polling
  - That userid should have Manage All permission level in eLRS
- Polling shall be performed on a 1 minute frequency
- Acknowledge events upon receipt

- Contact dsr_ops@pjm.com for more information

PJM All-Call

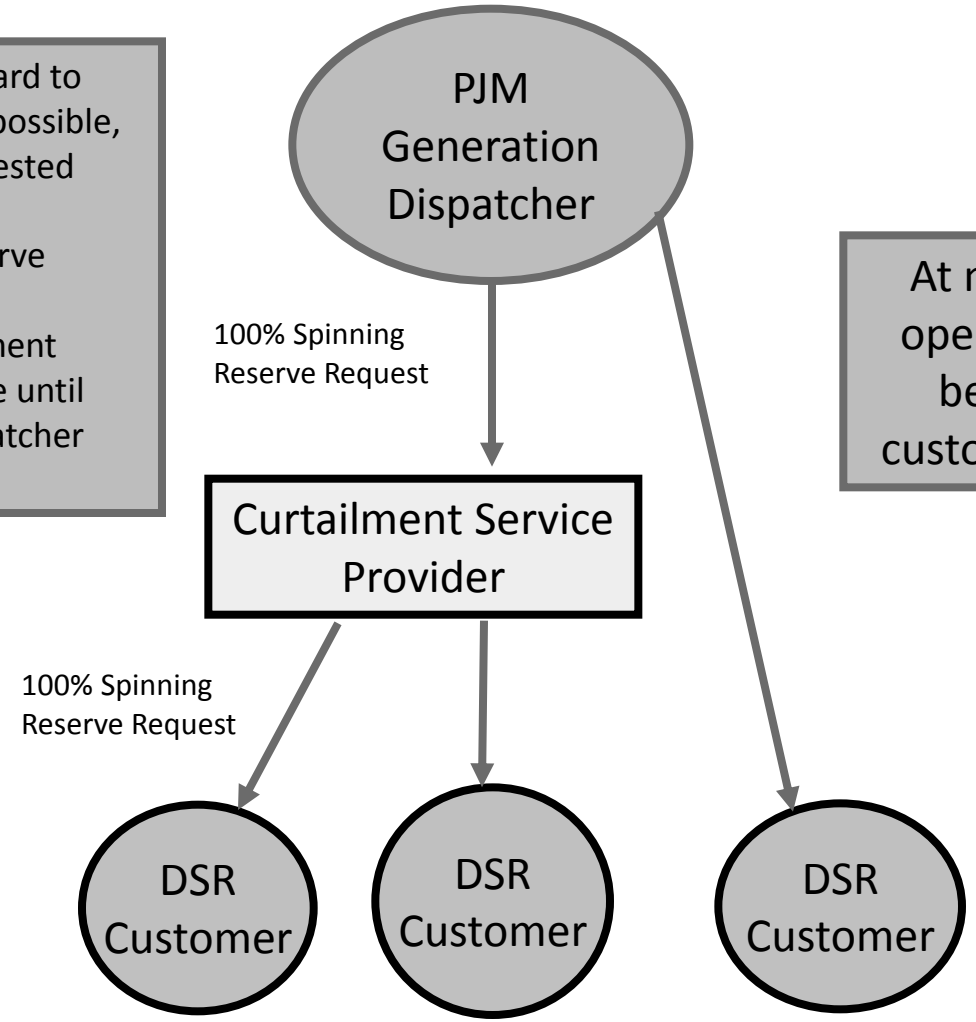
- Synchronized Reserve Events
  - Additional means of notification of Synchronized events will be via the PJM All-Call system
  - Used as confirmation for the Electronic Notification
  - Press ‘1’ to repeat message
  - Press ‘2’ to acknowledge receipt of message

Call for Synchronized Reserve from Demand Response

Loading of Synchronized Reserve is a Reliability service!

The CSP, without regard to price and as quickly as possible, implement the requested percentage of Synchronized Reserve

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

Agenda

- Regulation Market
- Synchronized Reserve Market
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Demand Response Requirements

The prerequisites for synchronized reserve participation include:

1. The DSR resource must have a minimum synchronized reserve capability of 0.1 MW
2. Demand Resources are limited to providing 33% of the Synchronized Reserve requirement
   - Demand resources that are considered to be “batch load” resources are limited to providing 20% of the Synchronized Reserve requirement.
3. Complete mandatory Ancillary Service training in the PJM LMS
   - Each company’s Training Liaison designates the individuals participating in the Regulation and/or Synchronized Reserve Markets

Demand Response Requirements

4. A Batch Load Demand Resource may provide Synchronized Reserve or Day-Ahead Scheduling Reserves. A Demand Resources that are considered to be "batch load" resources are limited to providing 20% of the Synchronized Reserve requirement. If PJM determines that satisfying 20 percent of the Synchronized Reserve requirement from Batch Load Demand Resources is causing or may cause a reliability degradation, PJM may reduce the percentage of the requirement that may be satisfied by Batch Load Demand Resources in any hour to as low as 10 percent

   - Batch Load Demand Resource are a Demand Resource that has a cyclical production process such that at most times during the process it is consuming energy, but at consistent regular intervals, ordinarily for periods of less than ten minutes, it reduces its consumption of energy for its production processes to minimal or zero megawatts

Request Synchronized Reserve Participation (Inflexible or Flexible) Normal Process

1. Request Ancillary Services participation in eLRS and select Synchronized Reserves
   — From the confirmed registration, select AS Enrollment Change and then select Synchronized Reserves

2. One Minute interval metering is required. CSP must provide a brief description of the meter installation process and quality assurance plan as it relates to the new DSR rules found in PJM Manual 11 (Scheduling Operations), Section 10.6 "Interval Meter Equipment and Load Data Requirements" (how CSP ensures that the meter equipment is accurately recording electricity consumption once it is operational and how CSP ensures accuracy overtime)
   ✓ http://www.pjm.com/documents/~/media/documents/manuals/m11.ashx

3. Complete the meter qualification form. If CSP has completed a prior version of this form for the location, then re-submittal is not necessary. CSP can put all registrations and associated locations (EDC account numbers) on one form. A copy of the form can be located at the following link:
   ✓ http://www.pjm.com/markets-and-operations/etools/~/media/etools/elrs/20090904-dsr-customer-ownder-meter-qualification-form.ashx

Request Synchronized Reserve Participation (Inflexible or Flexible) Normal Process

4. CSP needs to send an email with an attached meter data file to dsr_ops@pjm.com for PJM to review
   - ✓ The email needs to specify a registration's name and number for submitted meter data. The file needs to include 24 hours of one minute interval readings from the CSP owned Customer Meter and EDC Meter readings (at any interval) for the corresponding 24 hours. In case a registration does not have an interval EDC meter, a copy of the customer's a monthly electric bill can be submitted instead. In this case one minute data needs to be submitted for the same period of the time as it shown on the bill. The meter file should include a registration number and units of measure
   - ✓ Template for submitting the 1 – minute meter data:
     - http://www.pjm.com/markets-and-operations/etools/elrs/~/media/etools/elrs/elrs-synchronized-reserve-meter-data-submission-template-20101103.ashx

Request Synchronized Reserve Participation (Inflexible or Flexible) Normal Process

5. CSP is required to receive PJM's All Call for Synchronous Reserve notification. To receive the PJM All Call, the CSP must fill out the PJM Voice and All Call Communications Request form and send it back to PJM:
   - http://www.pjm.com/about-pjm/member-services/~/media/about-pjm/member-services/membership-assistant/pjm-voice-and-all-call-communications-request-form.ashx

Request Synchronized Reserve Participation (Inflexible or Flexible)
Ancillary Service Markets Registration Checklist

6. Complete the DSR – Ancillary Service Markets Registration Checklist
   — PJM will send CSP the Ancillary Service Markets Registration Checklist

Contact Information

Contact Type	Name	Company	Is company a "full" member of PJM?	Phone Number	Email
Business Contact		(Marketing Agent, CSP)			
Real Time Contact		(Company that will receive dispatch signal, event notification)			

Request Synchronized Reserve Participation (Inflexible or Flexible)

Ancillary Service Markets Registration Checklist

Resource Information

Resource Name	
Registration ID (from Economic Load Response Program) ***Note:*** Resource must be "Dispatchable by PJM" (check box in Load Response application)	
Location of Resource (city, state)	
Transmission Zone	
Reserve Zone and Sub-Zone (e.g., Mid-Atlantic, Eastern Sub-Zone)	
One-line – closest transmission substation?	
Ancillary Service to be provided by resource (Regulation, Synchronized Reserve)	
Number of MW to be provided by resource (minimum of 1 MW)	
Method of load reduction	

Training

Date the CSP attended DSR-Ancillary Services Training	
Name of Person that attended training	

Request Synchronized Reserve Participation (Inflexible or Flexible)

Ancillary Service Markets Registration Checklist

Synchronized Reserve

Is one-minute meter data available for this resource? What type of meter will be used?	
Method of submitting 1-min meter data following an event (CSV upload, XML web services)	
Date 1-minute meter data was approved by PJM Performance Compliance Department	
Date sample 1-minute meter data was uploaded into PJM test system	
Method of receiving PJM Spin Event Notifications (PJM All Call, EMS Alarming through SCADA link) ***Note:*** All Call Registration Form should be returned to PJM 5 business days prior to "go-live" date to allow time for setup and testing.	
Date Spin Event Notification setup was completed (All Call, EMS Alarming)	
Is this resource considered a batch load resource?	

Mandatory Training Requirement

1. Demand Resources must complete an initial training module on the requirements and business rules of the Regulation and Synchronized Reserve markets and the PJM All-Call responses. This training module is available online, through the PJM Learning Management System (LMS) and must be completed within 3 months of the individual beginning participation in Demand Response.
   - Anytime during this 3 month period that a Demand Resource individual is interacting with the PJM Regulation and Synchronized Reserve markets without having completed the requirement outlined above, he/she must work under the direct supervision of another individual who has met the requirement, either in person or via an on-call arrangement.

2. Demand Resources must annually complete a refresher training module on the requirements and business rules of the Regulation and Synchronized Reserve markets and the PJM All-Call responses. This training is available online, through the PJM LMS.

Mandatory Training Requirement

The following is the procedure for a company to "sign-up" each individual for the mandatory training.

1. **The first step** is for the company to designate a Training Liaison (point person in charge of monitoring that individuals have completed the initial training and subsequent refresher training)
   a. Send the Training Liaison Identification Form (DOC) found on the Member Training Liaison webpage http://pjm.com/training/member-training-liaison.aspx to trainingsupport@pjm.com
   b. Select CSP for Company Type on the form
   c. PJM will send the designated Training Liaison a spreadsheet to populate the company's roster with the information on the individuals who will be interfacing with the Regulation and/or Synchronized Reserve Markets

2. **The second step** is to send the populate spreadsheet to trainingsupport@pjm.com. Those individuals will be added to the company roster and given access to the mandatory training

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- Regulation Market
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Request Synchronized Reserve Participation in eLRS

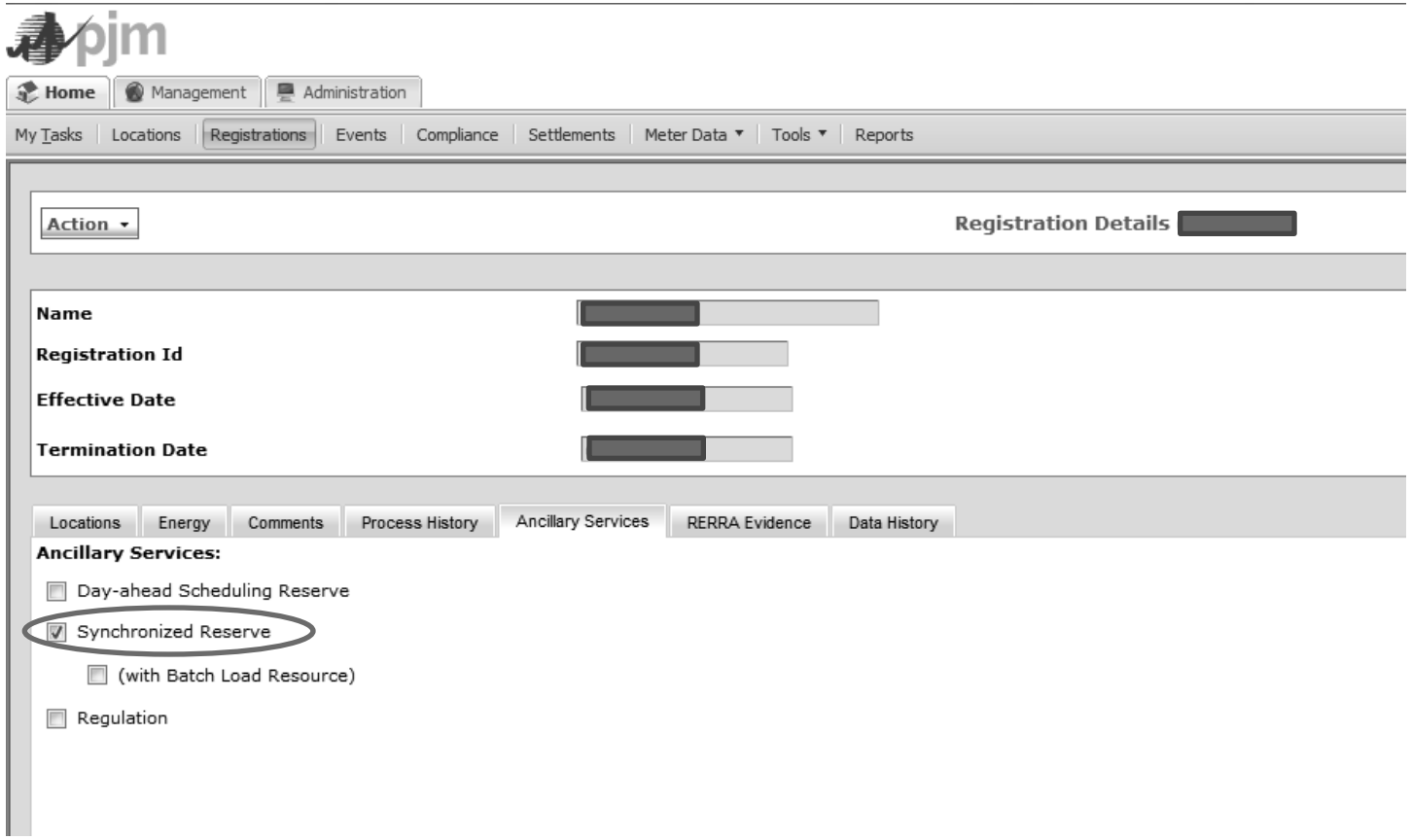
DSR resources must be approved by PJM prior to participating in the Synchronized Reserve Market

- There must be a confirmed Economic registration in eLRS prior to requesting Synchronized Reserve and/or Regulation participation
  - See the eLRS users guide for more details
    - http://pjm.com/markets-and-operations/etools/~/media/etools/elrs/elrs-user-guide-v2.0.ashx

Request Synchronized Reserve Participation in eLRS

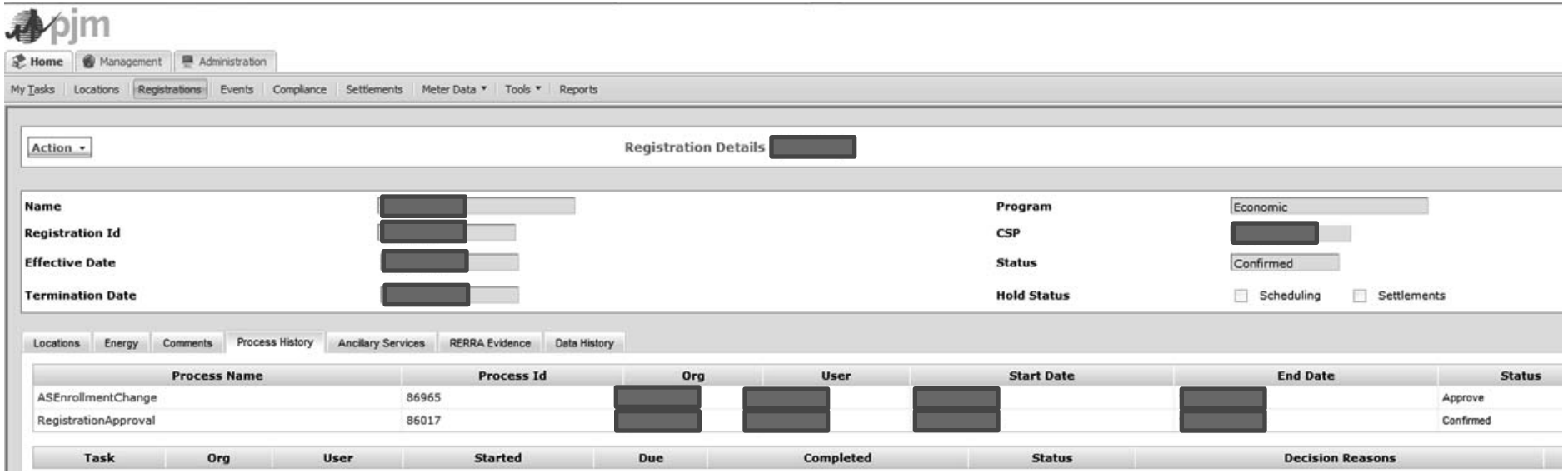
1. Under the Action button of the confirmed registration, select Request AS Enrollment Change

Request Synchronized Reserve Participation in eLRS



2. Select Synchronized Reserve
   - If the customer is a batch load facility, then select (with Batch Load Resource)

Request Synchronized Reserve Participation in eLRS



3. A task is created for PJM to review the prerequisites for synchronized reserve participation
   - The task can be seen under the Process History tab with the process name of ASEnrollmentChange
   - The Status shows the results of the PJM review
     - Pending
     - Approved
     - Denied

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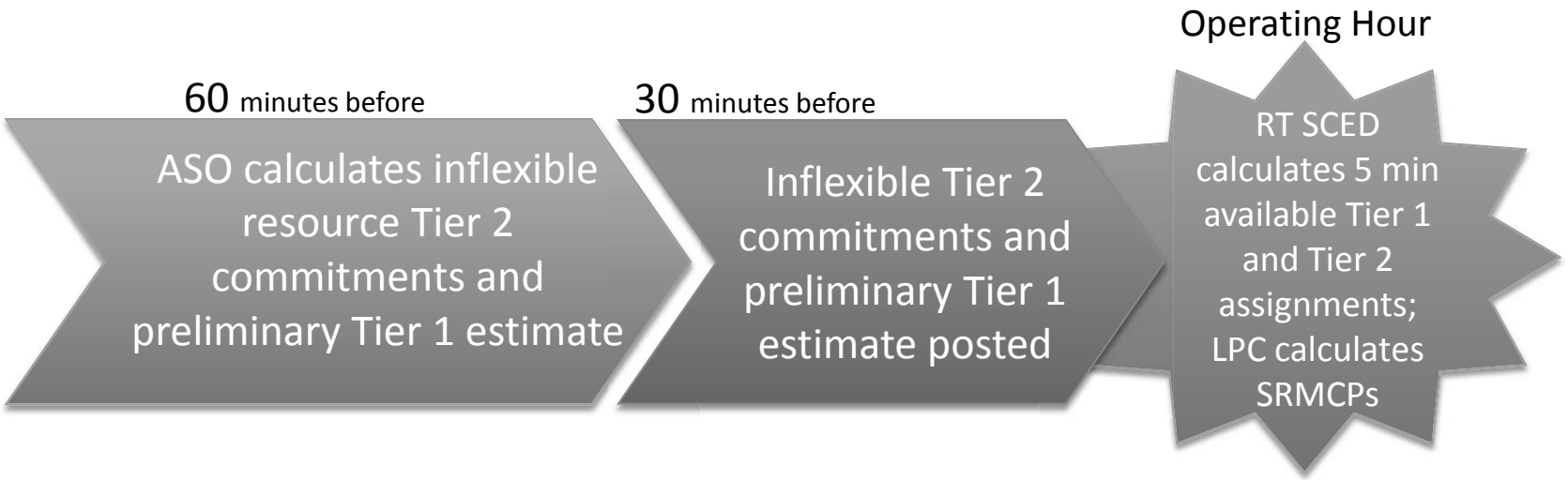
Prior to Operating Day

- Synchronized Reserve offer prices must be submitted by 1800 the day prior to the operating day
- Minimum MW offer is .1 MW (100 kW)
- All data submission pages in eMKT will be available prior to the operating day (each page will be discussed in detail later)

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 will be considered “inflexible” units and committed on a forward basis
- **Demand Resources have the option to be considered Flexible or Inflexible**

Synchronized Reserve Market

Requirements to Participate in the Synchronized Reserve Market:

1. Participating in the Synchronized Reserve Market requires DSR Hourly Updates for each hour of participation. Economic Max MW must be greater than Economic Min MW. SR may commit the resource as follows:
   a) If commit status on Hourly Update screen is **Economic** then SR may be committed for the lesser of {Offer Mw or (Economic Max – Economic Min)}
   b) If commit status on Hourly Update screen is **Unavailable** then SR may be committed for the lesser of {Offer Mw or Economic Max}

2. A Schedule Offer is required if there is to be an economic dispatch in either the Day-Ahead or Real Time Markets during the day. However, a Schedule Offer would not be required if it is only desired to participate in the Synchronized Reserve Market without being economically dispatched in either the Day Ahead or Real Time Markets

Synchronized Reserve Market

Requirements to Participate in the Synchronized Reserve Market:

3. Synchronized Reserve Offer MW, Offer Price and Available Status are entered under the Synchronized Reserve Market page

4. A Synchronized Reserve Offer and economic energy offers can simultaneously clear if MW do not overlap

5. If a DR registration is offered into both SR and Reg for same hour then PJM will take the lowest production cost offer

6. If a DR registration self scheduled both SR and Reg for same hour PJM always take the regulation offer

Synchronized Reserve Market – DSR Hourly Updates

DSR Hourly Updates when participating in Synchronized Reserve Market:

- ✓ A Price Schedule is required if also Economically Dispatched in either the Day Ahead or Real Time Markets
- ✓ A Price Schedule is not required if **only** participating in Synchronized Reserve Market
- ✓ DSR Hourly Updates are required. Economic Max must be greater than Economic Min. SR may commit the resource as follows:
  - a) If commit status on Hourly Update screen is **Economic** then SR may be committed for the lesser of {Offer Mw or (Economic Max – Economic Min)}
  - b) If commit status on Hourly Update screen is **Unavailable** then SR may be committed for the lesser of {Offer Mw or Economic Max}

Synchronized Reserve Market/Synchronized Reserve Offers

Synchronized Reserve Offers:

- ✓ Daily offers for Synchronized Reserves are entered in Synchronized Reserve Offers page
- ✓ Offer Prices ($) for Synchronized Market offers need to submitted by 6PM **prior** to the operating **day**. Offer quantities (MW) can be offered up until 60 minutes prior to the start of the operating **hour**

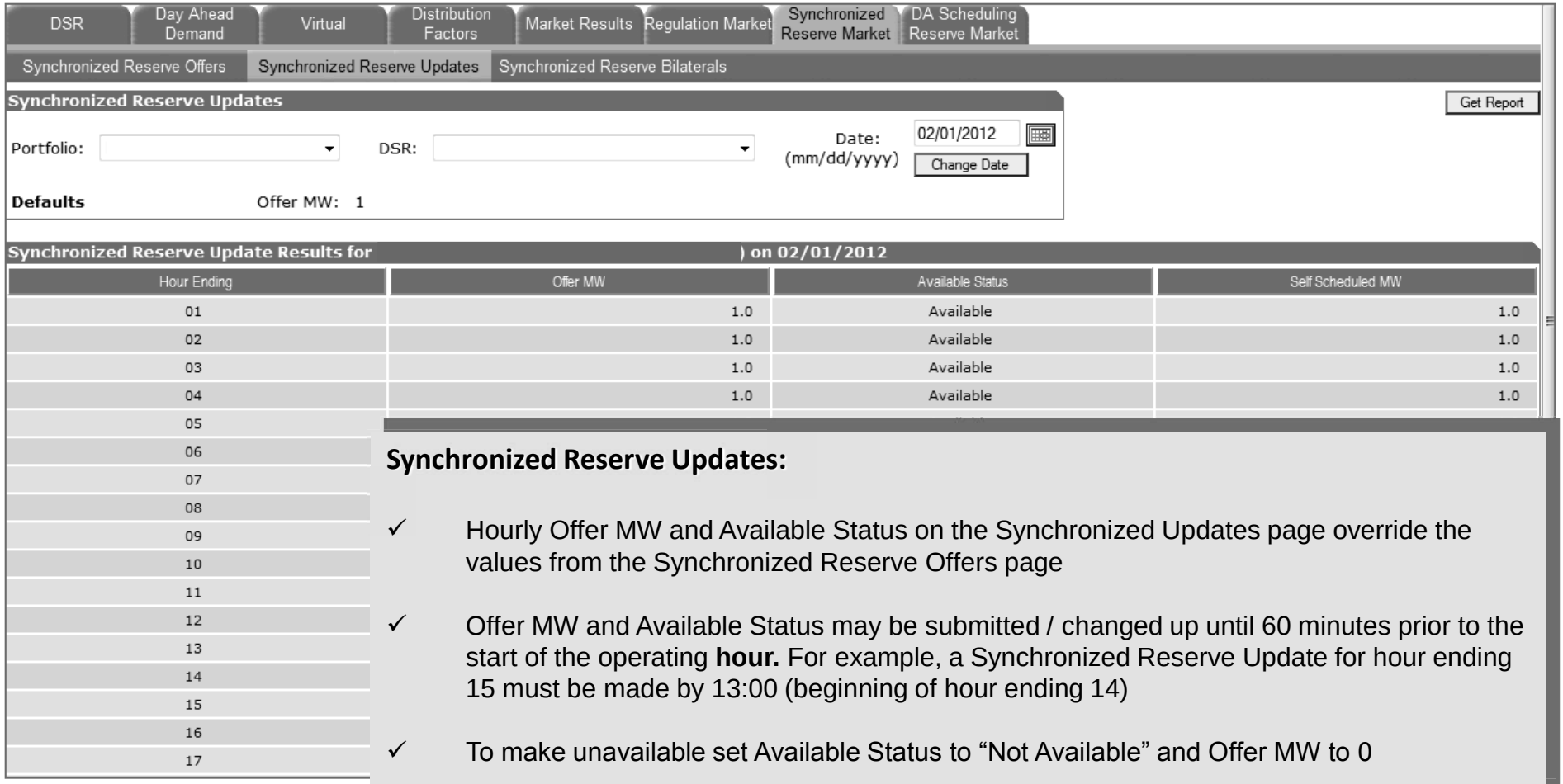
Synchronized Reserve Market/Synchronized Reserve Offers

Flexible – is a **daily** parameter that indicates whether the Demand Resource is to be considered Flexible or Inflexible.

The default value is "**False**"

- False – indicates that the DR is a Inflexible Tier2 resource
  - Scheduled hour-ahead for an entire hour
- True – indicates that the DR is an Flexible Tier2 resource
  - Scheduled 15 minutes ahead for a 5 minute interval

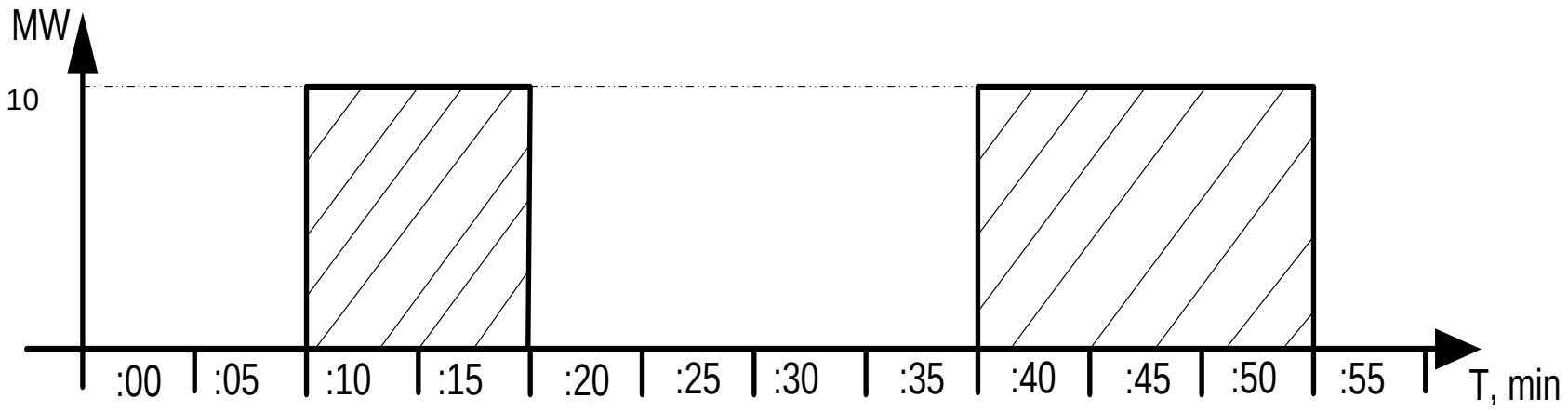
Synchronized Reserve Market/Synchronized Reserve Updates



Synchronized Reserve Updates:

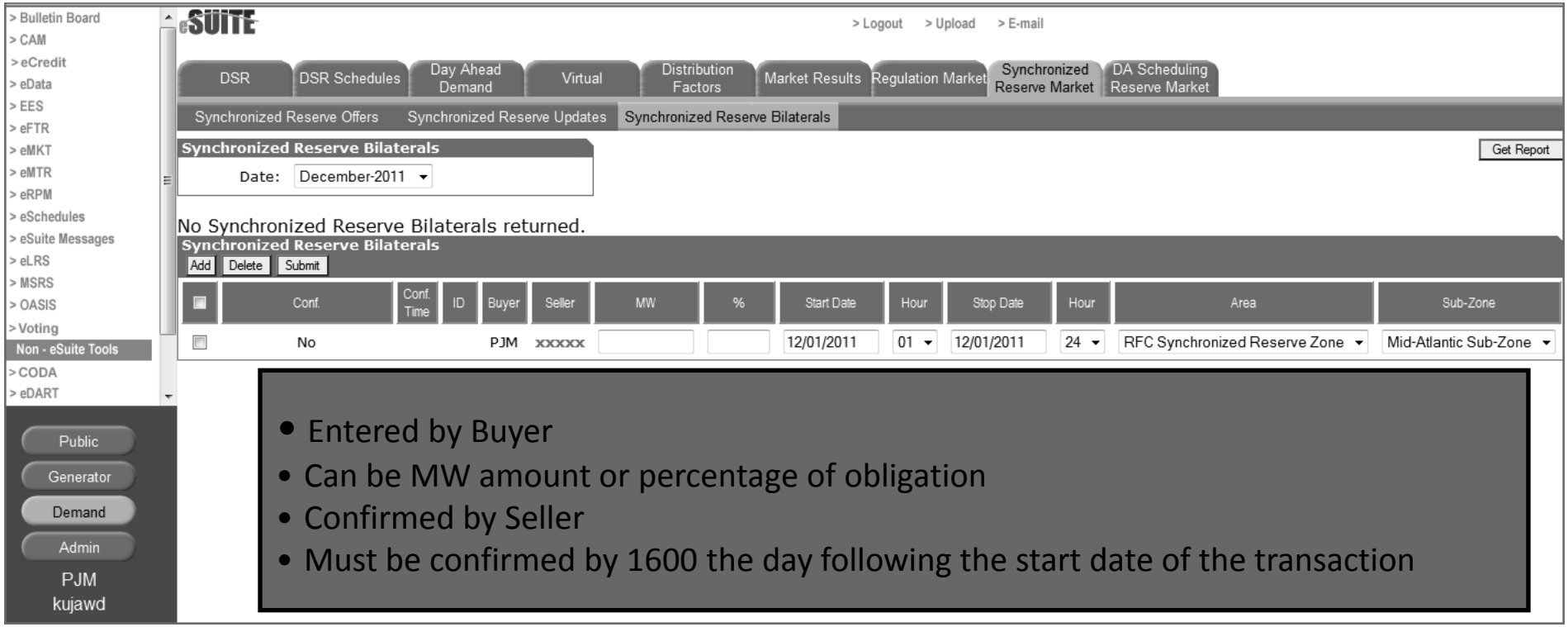
- ✓ Hourly Offer MW and Available Status on the Synchronized Updates page override the values from the Synchronized Reserve Offers page
- ✓ Offer MW and Available Status may be submitted / changed up until 60 minutes prior to the start of the operating **hour.** For example, a Synchronized Reserve Update for hour ending 15 must be made by 13:00 (beginning of hour ending 14)
- ✓ To make unavailable set Available Status to “Not Available” and Offer MW to 0
- ✓ The amount of Tier 2 commitment is dependent on the resource being available for energy:
  a) If commit status on **DSR Hourly Updates page** is **Economic** then SR may be committed for the lesser of {Offer Mw or (Economic Max – Economic Min)}.
  b) If commit status on **DSR Hourly Updates page** is **Unavailable** then SR may be committed for the lesser of {Offer Mw or Economic Max }.

Synchronized Reserve Participation as Flexible Resource



Event Start	Event End	Action
HH:02	HH:14	Not Obligated, but may respond as Tier 1
HH:02	HH:23	Not Obligated, but may respond as Tier 1
HH:15	HH:30	Obligated to respond and maintain reduction until end of the event
HH:22	HH:35	Not Obligated, but may respond as Tier 1

Synchronized Reserve Bilateral Transactions



- Entered by Buyer
- Can be MW amount or percentage of obligation
- Confirmed by Seller
- Must be confirmed by 1600 the day following the start date of the transaction

Regulation and Synchronized Reserve Market Results

Location	Reg A Offer MW	Reg D Offer MW	Tier-2 Offer MW	Self-Sched MW	Tier-2 MW	Reg A MW	Reg D MW	Reg TPS Result	Reg Offer Price Used	Actual Hourly Performance Score
	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.00	
	0.0	0.1	0.0	0.1	0.0	0.0	0.0	PASS	0.00	
	0.0	0.8	0.0	0.8	0.0	0.0	0.0	PASS	0.00	

Regulation assignments posted
30 minutes prior to the hour

Ancillary Service Market Prices

Real Time Hourly LMP Values for 20121102												
Start of Ancillary Service MCP Data	100	200	300	400	500	600	700	800	900	1000	1100	1200
RTO Regulation Performance	9.61	11.99	8.79	8.69	11.76	12.84	9.7	7.15	5.24	9.9	6.51	8.59
RTO Regulation Capability	25.92	13.78	20.49	14.43	27.15	28.07	33.13	45.38	18.51	32.56	52.44	41.71
RTO Marginal Benefits Factor	1	1	1	1	1	1	1	1	1	1	1	1
RTO Non-Synchronized Reserve	0	0	0	0	0	0	0	0	0	0	0	0
RTO Synchronized Reserve	0	0	0	0	0	0	0	0	0	0	0	0
MAD Non-Synchronized Reserve	0	0	0	0	0	0	0	5.78	0.08	3.29	13.45	0
MAD Synchronized Reserve	0	0	0	0	0	0	0	5.78	0.08	3.29	13.45	0
End of Ancillary Service MCP Data												

Regulation, Synchronized Reserve and Non-Synchronized Reserve Market Clearing Prices (MCPs) are posted with the Daily Real-Time LMP Files

Ancillary Services Market Clearing Prices are posted for hours ending 100 through hours ending 2400

Synchronized Reserve Market Results (Public)

Messages | Reports | Node List | Market Results Energy | Market Results A/S

A/S Market Prices | Regulation Results | Synchronized Reserve Results | Primary Reserve Results | DA Scheduling Reserve Results

Synchronized Reserve Results Search

Area: MAD Date: (mm/dd/yyyy) 11/02/2012 Change Date

This information posted 30 Minutes prior to the hour

Get Report

Get CSV Report

Data provided on this page is based on an hour ahead projection. Actual values may vary in real time depending on changes in system conditions.

Synchronized Reserve Results for 11/02/2012

Hour	Requirement	Tier-1 Est. Projected	Avail. Transfer Projected	Tier-2 Req. Projected	Tier-2 Self-Sched.	Tier-2 Assigned Preliminary	Total Preliminary	Deficiency Preliminary	SRMCP
01	1175	1110	1268.6	0	0	0	1110	0	
02	1175	1235	963.4	0	0	0	1235	0	
03	1175	1182	787.4	0	0	0	1182	0	
04	1175	1320	925.3	0	0	0	1320	0	
05	1175	1193	959.5	0	0	0	1193	0	
06	1175	984	699.9	0	0	0	984	0	
07	1175	841	619.8	0	0	0	841	0	
08	1175	975	473.5	0	0	0	975	0	
09	1175	964	459.3	0	0	0	964	0	
10	1175	1021	603.6	0	0	0	1021	0	
11	1175	916	635.7	0	0	0	916	0	
12	1175	933	680.6	0	0	0	933	0	

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Up load Meter Data in eLRS

- CSP must upload load data in the eLRS for all SR events if they cleared in the market (does not depend on duration of event)
- CSPs must upload 1 minute data with 2 business days after SR event
- CSPs should provide 1 minute data for a minimum of 10 minutes before the start of the event to 10 minutes after the event end
- A template for the meter data submission is posted on the PJM website:
  - Markets & operations > eLRS > eLRS Meter Data Management (non-webservices) > Economic Ancillary Services Example

Registration	Account	Date	Type	UOM	Value
R7271	01234567891	05/29/2012 15:01	MinuteLoad	KW	4001
R7271	01234567891	05/29/2012 15:02	MinuteLoad	KW	4021
R7271	01234567891	05/29/2012 15:03	MinuteLoad	KW	4011
R7271	01234567891	05/29/2012 15:04	MinuteLoad	KW	4015
R7271	01234567891	05/29/2012 15:05	MinuteLoad	KW	4011

Monitoring and Verification

- CSP or associated DR resources that do not provide timely load data may be suspended from SR market
  - until corrective measures are implemented and may be referred to the PJM Market Monitor and/or the FERC Office of Enforcement for further investigation as necessary

- CSP are required to respond to SR events when they receive dispatch instructions from PJM – they should not wait to determine if event will be >10 minutes before responding

- Resource responses are verified by the PJM Performance Compliance Department following each event

- Actual responses compared to assignments at start of Synchronized event used to determine penalties

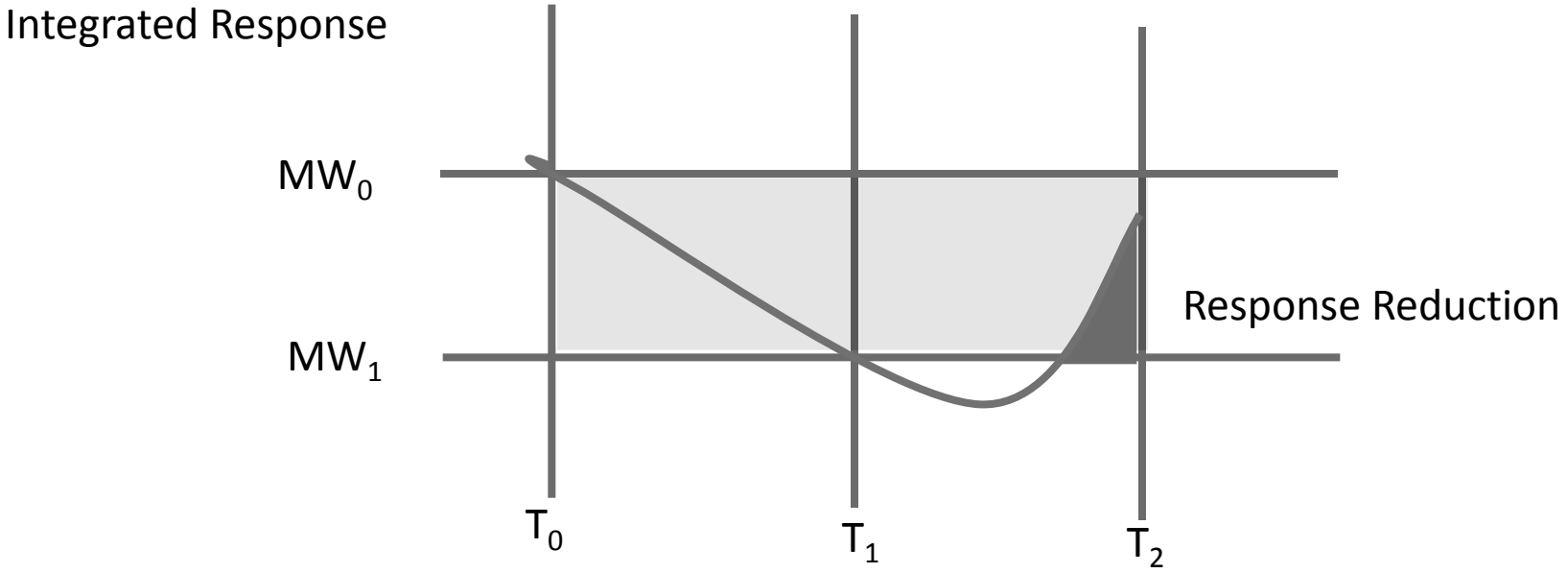
Monitoring and Verification

- The magnitude of each resource‘s response to a synchronized reserve event (both Tier 1 and Tier 2) is the difference between the resource‘s meter reading at the start of the event and its meter reading ten minutes after the start of the event. In order to allow for small fluctuations and possible delays, meter readings at the start of the event is defined as the greatest meter reading between one (1) minute prior to and one (1) minute following the start of the event. Similarly, a resource‘s meter reading ten minutes after the event is defined as the lowest meter reading achieved between nine (9) and eleven (11) minutes after the start of the event

Monitoring and Verification – Batch Load Resource

- For demand resources that are considered ”batch load” resources, a second method of verification will be used for instances where a synchronized reserve event is initiated and the resource is operating at the minimum consumption level of its duty cycle. In this case, the magnitude of the response will be measured as the difference between (a) the resource‘s consumption at the end of the event and (b) the maximum consumption within a ten (10) minute period following the event provided that all subsequent minutes following that minute are no less than 50% of the consumption in that minute

Monitoring and Verification



MW_0 is the highest load at T_0 (start) +/- one minute

MW_1 is the lowest output at T_1 (10 minutes, or event end, if sooner) +/- one minute

T_2 is the end of the event or 30 minutes past the start of the event

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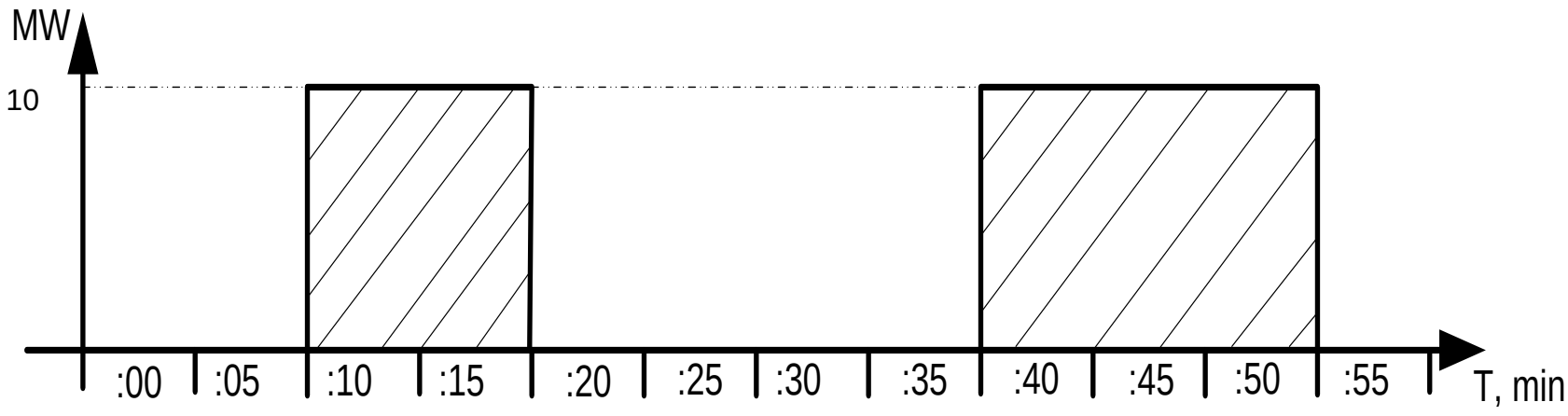
Tier 2 Settlement Credits

PJM calculates the hourly Synchronized Reserve credits for each Tier 2 resource as follows:

- These credits are awarded to resource owners that have either assigned self-scheduled or pool-scheduled synchronized reserve.
- Synchronized reserve credits for resources assigned self-scheduled synchronized reserve equal the Tier 2 clearing price times the resource's self-scheduled synchronized reserve capability less any shortfall due to failure to provide assigned capability during a synchronized reserve event.
- Synchronized reserve credits for resources that are assigned pool-scheduled synchronized reserve are the higher of: the Tier 2 clearing price times the resource's assigned synchronized reserve capability less any shortfall due to failure to provide assigned capability during a synchronized reserve event or the resource's synchronized reserve offer times its assigned synchronized reserve capability less any shortfall due to failure to provide assigned capability during a synchronized reserve event (plus opportunity cost, energy use costs, and startup costs incurred, for generators), as applicable.

Sample Intra-Hour Tier 2 Commitment



DSR Tier 2 PJM-Scheduled MWh
= 10 * (25/60) = 4.17

Tier 2 Settlement Credits

2. **DSR Synch Reserve Lost Opportunity Cost Credit**
   - DSR Synch Reserve Lost Opportunity Cost Credit Cleared = MAX (DSR Synch Reserve Offer Amount – DSR SRMCP Credit, 0)

3. **Economic Settlement for reduction during event**
   - Economic settlement for non-overlapping MWh with synchronized reserve
   - Submitted in eLRS

Tier 1 Settlement Credits

A Demand Resource that responds to a synchronized reserve event and did not have an obligation (MW that did not clear as Tier 2) will be credited Tier 1 for any decrease in consumption provided over the event. The Tier 1 settlement compensation is as follows:

1. **Tier 1 Settlement Credit (when not in Shortage)**
   - **When Non-Synchronized Reserve Market Clear Price = 0**
   - DSR Synch Reserve Tier 1 Credit = DSR Synch Reserve Tier 1 Response * MAX((synchronized reserve energy premium) – hourly RT LMP),0)

   A. DSR Synch Reserve Tier 1 Response is prorated MWh response over the time period of the event
      - An 18 MW response over a 18 minute period becomes 18 MW * 18 min * 1 hour/60 min = 5.4 MWh response

Tier 1 Settlement Credits

B. Synchronized reserve energy premium is defined as the average of the 5-minute LMPs calculated over the synchronized reserve event plus $50/MWh
   - An 18 minute event would use the average LMP over four 5-minute intervals
   - $50/MWh is added to the average of the 5-minute LMPs

C. Hourly RT LMP is the integrated hourly RT LMP during the event

Tier 1 Settlement Example – Non Shortage

DR Resource responds to an Synchronized Reserve Event while not having a Synchronized Reserve Tier 2 assignment

- **Duration of Synchronized Reserve Event:** 18 minutes
- **Reduction during the event:** 18 MW
- **Interval LMPs during the event:** $55/MWh, $55/MWh, $80/MWh, $70/MWh

1. The MW reduction is scaled by the duration of the event to become a MWh value. That is, an 18 MW response over a 18 minute period becomes 18 MW * 18 min * 1 hour/60 min = 5.4 MWh response.

2. Average of 5-minute LMPs at the bus of the resource responding as Tier1 over the course of spin event = ($55/MWh + $55/MWh + $80/MWh + $70/MWh)/4 = $65/MWh

3. If RT LMP for the hour = $47/MWh and energy premium = $65/MWh + $50/MWh then
   - Credit for Tier1 response =
   - 5.4 MWh * [($65/MWh + $50/MWh) - $47/MWh] = $367.20

Tier 1 Settlement Credits

2. Tier 1 Settlement Credit (when in Shortage)

When Non-synchronized Reserve Market Clear Price > 0

DSR Synch Reserve Tier 1 Credit = DSR Synch Reserve Tier 1 Response * SRMCP

A. Treated like Tier 2 and compensated at SRMCP
B. DSR Synch Reserve Tier 1 Response is prorated MWh response over the time period of the event
   - An 18 MW response over a 18 minute period becomes 18 MW * 18 min * 1 hour/60 min = 5.4 MWh response
C. SRMCP is the Synchronized Reserve Market Clearing Price

Penalties

1. No penalties exist for Tier 1 (payment made for actual response only)
2. The resource is credited for Tier 2 Synchronized Reserve capacity in the amount that actually responded for all hours the resource was assigned or self-scheduled Tier 2 Synchronized Reserve on the day the event occurred. The owner of the resource incurs a retroactive obligation to be refunded at the applicable SRMCP for the following:
    1. Amount of shortfall measured in MW for all hours the resource was assigned or self-scheduled over immediate past interval
        a) The duration of the interval is determined as lesser of 15 days or number of days since last non-performance
    2. Aggregate response can be used to offset retroactive obligation

Detail description in section 4.2.12 of M-11, and section 6.3 of M-28

Tier 2 Example 1

Scenario #1: One event on the day, no event in the last 15 days				
January 16th – Event Results				
DSR	Assigned	Response	Under Response	Over Response
A	3	0	3	0
B	5	5	0	0
C	0.5	0.5	0	0

1. DSR A: Penalty of 3 MW applied to all hours the DSR assigned on January 16th. Retroactive charge: Pays 3MW * applicable SRMCP for Jan 1st – 15th.
2. DSR B: No penalty
3. DSR C: No penalty

Tier 2 Example 2

Scenario #2: One event on the day, DSR A was also penalized for an event on January 10				
January 16th – Event Results				
DSR	Assigned	Response	Under Response	Over Response
A	3	0	3	0
B	5	5	0	0
C	0.5	0.5	0	0

1. DSR A: Penalty of 3 MW applied to all hours the DSR assigned on January 16th. Retroactive charge: Pays 3MW * applicable SRMCP for Jan 11th – 15th.
2. DSR B: No penalty
3. DSR C: No penalty

Tier 2 Example 3

Scenario #3: One event on the day, no event in the last 15 days. Over response from other DSRs by the same owner covers the under response				
January 16th – Event Results				
DSR	Assigned	Response	Under Response	Over Response
A	3	1	2	0
B	5	8	0	3
C	0.5	0.5	0	0

- DSR A: Penalty of 2 MW applied to all hours the DSR assigned on January 16th. No retroactive charge since over response from DSR B covers under response of DSR A
- DSR B: No penalty
- DSR C: No penalty

Tier 2 Example 4

Scenario #4: One event on the day, no event in the last 15 days. Over response from other DSRs by the same owner partially covers under response					
January 16th – Event Results					
DSR	Assigned	Response	Under Response	Over Response	Prorated Penalty Obligation
A	3	1	2	0	0.4
B	5	7	0	2	0
C	0.5	0	0.5	0	0.1

1. DSR A: Penalty of 2 MW applied to all hours the DSR assigned on January 16th. Retroactive charge: Pays 0.4 MW*applicable SRMCP for January 1st – 15th
2. DSR B: No penalty
3. DSR C: Penalty of 0.5 MW applied to all hours the DSR assigned on January 16th. Retroactive charge: Pays 0.1 MW *applicable SRMCP for January 1st – 15th

Tier 2 Example 5

Scenario #5: Multiple event on the day, no event in the last 15 days									
January 16th – Event Results									
	1st Event: 8:35 to 8:55					2nd Event: 13:15 to 13:32			
DSR	**Assigned**	**Response**	**Under Response**	**Over Response**		**Assigned**	**Response**	**Under Response**	**Over Response**
A	3	1	2	0		3	2	1	0
B	5	5	0	0		5	5	0	0
C	0.5	0.5	0	0		0.5	0.5	0	0

1. DSR A: Penalty of 2 MW applied to all hours the DSR assigned on January 16th. Retroactive charge: Pays 2MW * applicable SRMCP for Jan 1st – 15th.
2. DSR B: No penalty
3. DSR C: No penalty
4. Maximum under response for all events in the day applied to the day

CSP Resources

- **For Portfolios and bidding**
  - eMKT User Guide
- **For Business Rules**
  - PJM Manual 11:
  - http://www.pjm.com/~/media/documents/manuals/m11.ashx
  - Section 4.1 and 4.2
- **For Synchronized Reserve Accounting**
  - Operating Agreement Accounting - PJM Manual 28:
  - http://www.pjm.com/~/media/documents/manuals/m28.ashx
  - Section 6

Agenda

- Regulation Market
- Synchronized Reserve Market
- **Day Ahead Scheduling Reserve Market**
  - **Market-based Day Ahead Scheduling Reserve Overview**
  - Request DASR Participation in eLRS
  - DASR Participation through eMKT
  - DASR Monitoring and Verification

What is Day-ahead Scheduling Reserve?

- On a daily basis, PJM must schedule enough capacity to cover the forecast load plus expected sales of energy off the system and operating reserves

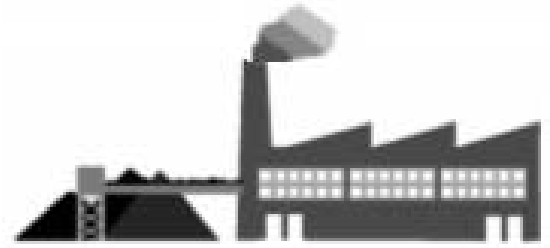
Required Capacity =
Load Forecast + Sales + Reserves

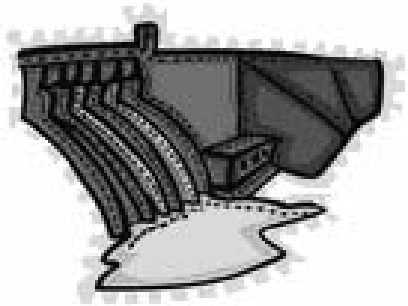
RFC Day-ahead Scheduling Reserve
VACAR Day-ahead Scheduling Reserve

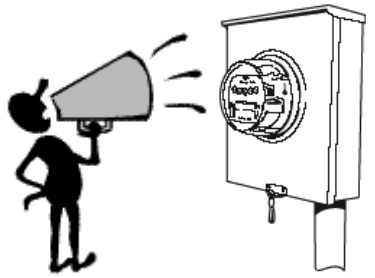
Who Can Provide Reserves?

Resources with the ability to provide reserve capability in 30 minutes including primarily:

- Online Steam generation with capability to increase output from DA dispatch point
- Offline CTs that can start to provide Reserve
- Hydro and Pumped Storage Units
- Dispatchable DSR resources

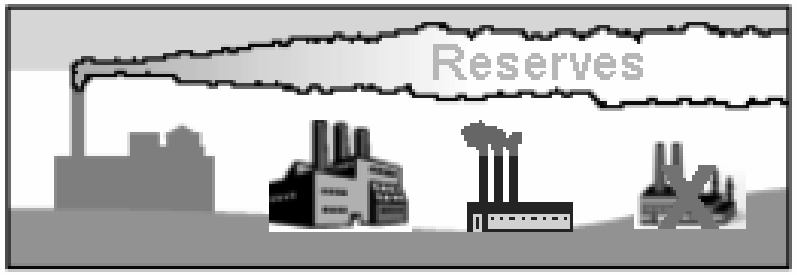






Day-ahead Scheduling Reserves

- PJM schedules reserves on a day-ahead basis in order to ensure that differences in forecasted loads and forced generator outages do not negatively impact system reliability
- Day-ahead Scheduling Reserve Requirement is calculated on an annual basis



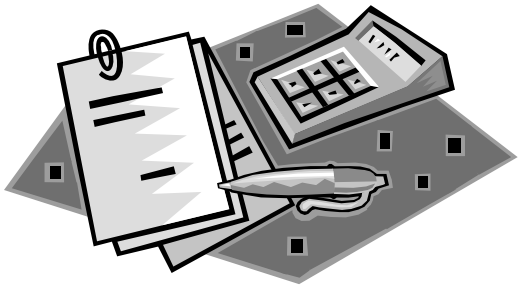
Day-ahead Scheduling Reserve Calculation

Day-ahead Scheduling Reserves = Underforecasted LFE + FOR

Load **F**orecast **E**rror Component **(LFE)**

Forced **O**utage **R**ate Component **(FOR)**

Applies to the RFC DASR Requirement Only!



Load Forecast Error Component

Day-ahead Scheduling Reserves = Underforecasted LFE + FOR

Load **F**orecast **E**rror Component **(LFE)**

- Focus is on under-forecasted Load Forecast errors which can result in a capacity deficiency
- Based on the 80th percentile of a rolling three year underforecasted average
- Effective January 1, 2013 LFE error component of Day-ahead Scheduling Reserve is 2.13%

Applies to the RFC DASR Requirement Only!

Forced Outage Rate Component

Day-ahead Scheduling Reserves = Underforecasted LFE + FOR

Forced **O**utage **R**ate Component **(FOR)**

- Based on a rolling three year average of forced outages that occur from 18:00 the scheduling day (day-1) through the operating day at 20:00
- Duration covers timeframe after the Reserve Adequacy Run through the evening peak period for which the system is scheduled
- Additional reserves can be scheduled if Hot/Cold Weather Alert is issued
- Effective January 1, 2013 the FOR error component of the Day-ahead Scheduling Reserve is 4.66%

Applies to the RFC DASR Requirement Only!

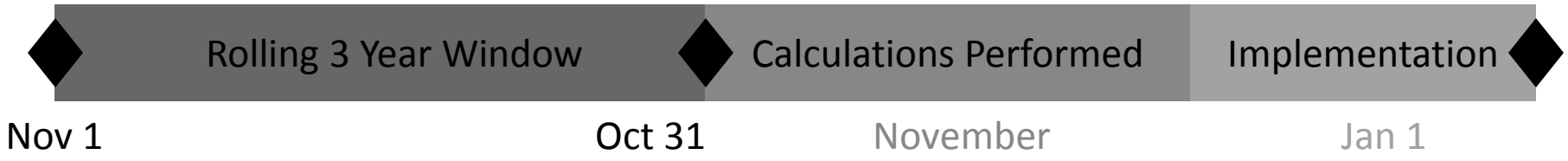
Day-ahead Scheduling Reserve Requirement (RFC)

- **2014 LFE component is 2.11%**
- **2014 FOR component is 4.16%**
- **Total 2014 DASR Requirement is 6.27%**

Applies to the RFC DASR Requirement Only!

Day-ahead Scheduling Reserve Requirement Timeline

- Calculated annually during the month of November
- Calculation covers three year window
  - November 1st (year -3) through October 31st (Current Year)
- Results communicated to Market Implementation Committee, Operating Committee and System Operations Subcommittees
- Calculations implemented annually on January 1st
- **Example**



Reserves

Reserves are additional generation capacity above the expected load. Scheduling excess capacity protects the power system against the uncertain occurrence of future operating events, including the loss of energy or load forecasting errors

<table>
<tr><td colspan="3">Day-Ahead Scheduling Reserve
(T ≤ 30 Min)</td></tr>
<tr><td colspan="2">Contingency (Primary) Reserve
(T ≤ 10 Min)</td><td rowspan="2">Secondary Reserve
(10 Min ≤ T ≤ 30 Min)</td></tr>
<tr><td>Synchronized Reserve
(Synchronized)</td><td>Non-Synchronized Reserve
(Off-Line)</td></tr>
<tr><td colspan="3">T = Time Interval Following PJM Request</td></tr>
</table>

The Day-ahead Scheduling Reserve requirement is the sum of the requirements for all zones within the RTO and any additional reserves scheduled in response to an RTO-wide Hot or Cold Weather Alert or other conservative operations

Day-ahead Scheduling Reserve Market Methodology

- The RFC Day-ahead Scheduling Reserve cleared in the Day-ahead Market is the annual DASR requirement times the RFC Peak Load Forecast at 1200 hours
- The RFC Day-ahead Scheduling Reserve scheduled in the Reserve Adequacy Commitment is the annual DASR requirement times the RFC peak load forecast at 1800 hours
- Dominion Day-ahead Scheduling Reserve is based on their share of the VACAR Reserve Sharing Agreement and is set annually (431 MW for 2014)
- The RFC and Dominion Day-ahead Scheduling Reserve Requirements are added together to form a SINGLE RTO Day-ahead Scheduling Reserve Requirement which is scheduled economically across the RTO

Day-ahead Scheduling Reserve Market Overview

- The Day-ahead Scheduling Reserve product is :
  - Offer-based market for 30-Minute Reserve that can be provided by both Generation and Demand Resources
  - Market that is designed to clear existing Day-Ahead Scheduling (operating) reserve requirements as defined by reliability standards: (RFC & SERC)
  - Day-ahead, forward market that clears simultaneously with Day-Ahead Energy Market
  - Costs of Day-ahead Scheduling Reserve product will be allocated by real-time load ratio share

Purpose: To encourage and incent generation and demand resources to provide the flexible capability to provide 30-minute reserves

Demand Resources – Dispatchable in Real Time

- Demand Resources must be registered as an economic registration in the eLRS, indicate that they can be dispatchable by PJM in real-time and be able to be reduced within 30 minutes
- Day-Ahead Scheduling Reserve offers are entered in eMKT

Demand Response Requirements

- Demand Resources providing Day-Ahead Scheduling Reserve are required to provide metering information at no less than a one minute scan
- Metering information for demand resources is not required to be sent to PJM in real time. Daily uploads at the close of the next business day after the operating day, if both cleared for DASR and dispatched in the corresponding real time hour
- Demand Resources are limited to providing 25% of the RTO Day-Ahead Scheduling Reserve Requirement
- Minimum MW offer is .1 MW (100 kW)

Demand Response Requirements – Batch Load

- Load response resources that are considered “batch load” resources as defined in the Synchronized Reserve Market detailed in PJM Manual for Scheduling Operations (M-11) may participate in the Day-ahead Scheduling Reserve market under the same conditions as exist for Synchronized Reserve with respect to having already reduced prior to receiving a PJM dispatch instruction to do so
- Such resources must remain off line for the duration of the PJM dispatch request in order to receive the Day-ahead Scheduling Reserve market payment

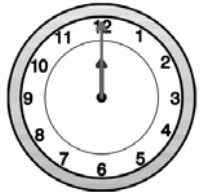
Demand Response Requirements – Batch Load

- A Batch Load Demand Resource may provide Synchronized Reserve or Day-Ahead Scheduling Reserves. A Demand Resources that are considered to be "batch load" resources are limited to providing 20% of the of the total system wide Day-Ahead Scheduling Reserve requirement. If PJM determines that satisfying 20 percent of the total system wide Day-Ahead Scheduling Reserve requirement from Batch Load Demand Resources is causing or may cause a reliability degradation, PJM may reduce the percentage of the requirement that may be satisfied by Batch Load Demand Resources in any hour to as low as 10 percent
  - Batch Load Demand Resource are a Demand Resource that has a cyclical production process such that at most times during the process it is consuming energy, but at consistent regular intervals, ordinarily for periods of less than ten minutes, it reduces its consumption of energy for its production processes to minimal or zero megawatts

When Will the DASR Market Clear?

- DASR Market will clear simultaneously with the DA Energy Market

- DASR Offers for the next operating day are submitted by 12:00 pm



- DASR Results are posted at 1600 in eMKT

PJM will post preliminary DASR rates on PJM.com

DASR Clearing Process

- DASR Clearing Process
  - Is a simultaneous, least-cost optimization with the energy market as part of the Day-Ahead Market mechanism.
  - The Day-ahead Scheduling Reserve Requirement will be calculated based on the PJM RTO load forecast for the upcoming operating day.
  - Will result in an hourly RTO clearing price for Day-ahead Scheduling Reserve for the next day

A non-zero clearing price can result even when reserves are <u>not</u> deficient

DASR Clearing Price

- The Day-ahead Scheduling Reserve Market clearing price
  - Is set equal to the merit order price of the highest cost Day-ahead Scheduling Reserve resource necessary to meet the remaining requirement

- Both generator startup costs and demand resource shutdown costs are divided over the expected commitment period for the resource, as part of the market clearing process. Neither of these costs are included in the clearing price
  - Day-ahead Scheduling Reserve start-up costs are defined as applicable generator startup costs required to provide Day-ahead Scheduling Reserve or demand resource shutdown costs required to provide Day-ahead Scheduling Reserve

How will resources provide Day-Ahead Scheduling Reserve?

- Unlike Synchronized Reserves, the Day-Ahead Scheduling Reserve Requirement is not maintained in Real Time
  - There are no Day-ahead Scheduling Reserve events for resources to respond
  - Resources will be responding to normal PJM dispatch instructions
- Those resources receiving a day-ahead award for Day-ahead Scheduling Reserve would receive the hourly clearing price for the awarded MW amount as long as they were capable of providing the reserve in real time as scheduled
- Performance will be measured after the fact
  - No Penalty for non-performance (penalty = forgone revenue)

Interaction of Reserve Market Products

- Resources can be capable of providing all three reserve products:
  - Synchronized Reserve, Regulation, and Day-ahead Scheduling Reserve
- All three cannot be provided simultaneously, only two products, at most

Day-ahead Scheduling Reserve + Regulation	YES
Day-ahead Scheduling Reserve + Synchronized Reserve	YES
Day-ahead Scheduling Reserve + Sync Reserve + Regulation	NO

Day-Ahead Scheduling Reserve Credits

- **DASR Credit**
- DASR MCP * Cleared DASR MWh

- **Nonperformance**
- Forfeiture of revenue over hours assigned for the day

Who will pay for DA Scheduling Reserve?

- Day-ahead Scheduling Reserve settlement is a zero-sum calculation based on the Day-ahead Scheduling Reserve provided to the market by generation and demand resource owners and purchased from the market by participants

- Each Load Serving Entity (LSE) on the PJM system incurs a Day-ahead Scheduling Reserve obligation in kWh based its load ratio share within the RTO times the amount of Day-ahead Scheduling Reserve assigned in the RTO

Agenda

- Regulation Market
- Synchronized Reserve Market
- **Day Ahead Scheduling Reserve Market**
  - Market-based Day Ahead Scheduling Reserve Overview
  - **Request DASR Participation in eLRS**
  - DASR Participation through eMKT
  - DASR Monitoring and Verification

Request Day Ahead Scheduling Reserve Participation in eLRS

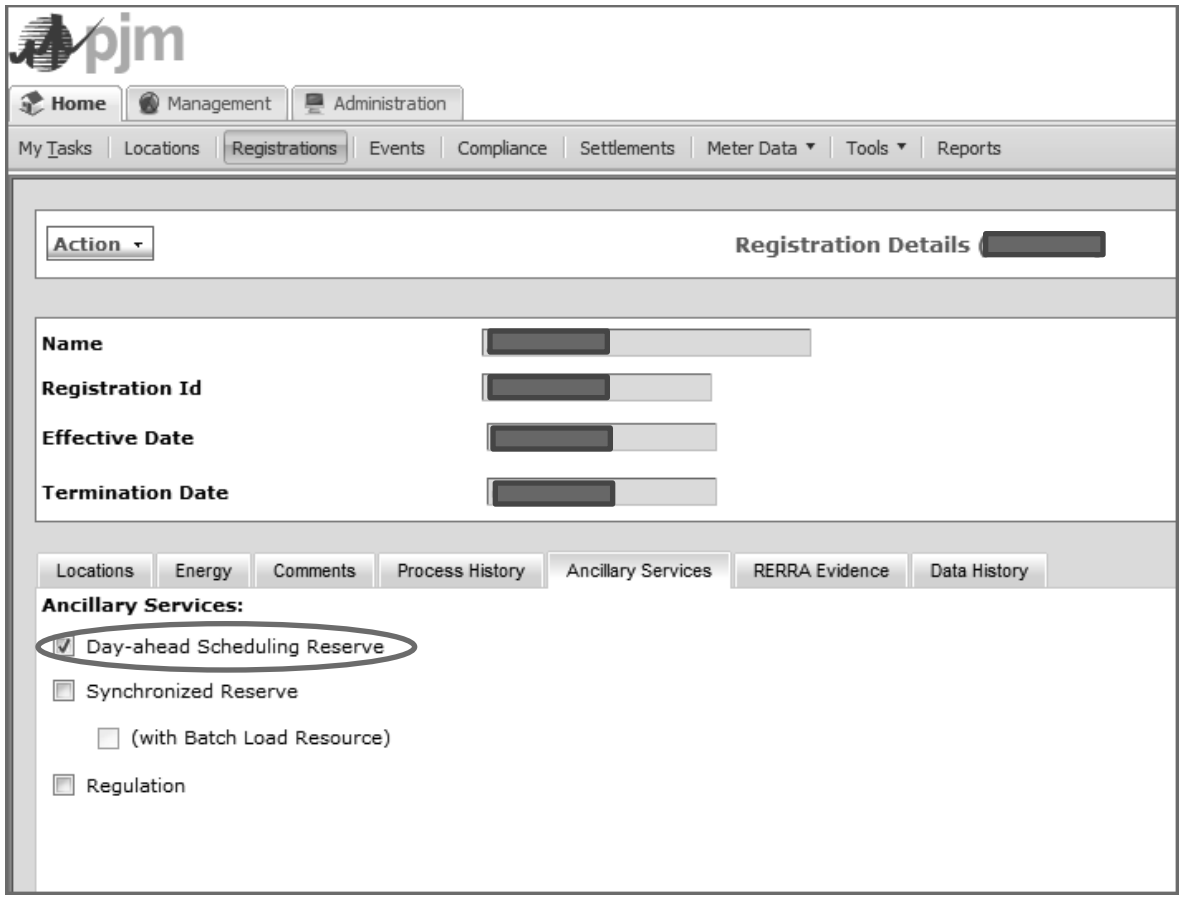
- DSR resources must be approved by PJM prior to participating in the Day Ahead Scheduling Reserve Market

- There must be a confirmed Economic registration in eLRS prior to requesting Regulation participation.
  - See the eLRS users guide for more details
    - http://pjm.com/markets-and-operations/etools/~/media/etools/elrs/elrs-user-guide-v2.0.ashx

Request Day Ahead Scheduling Reserve Participation in eLRS

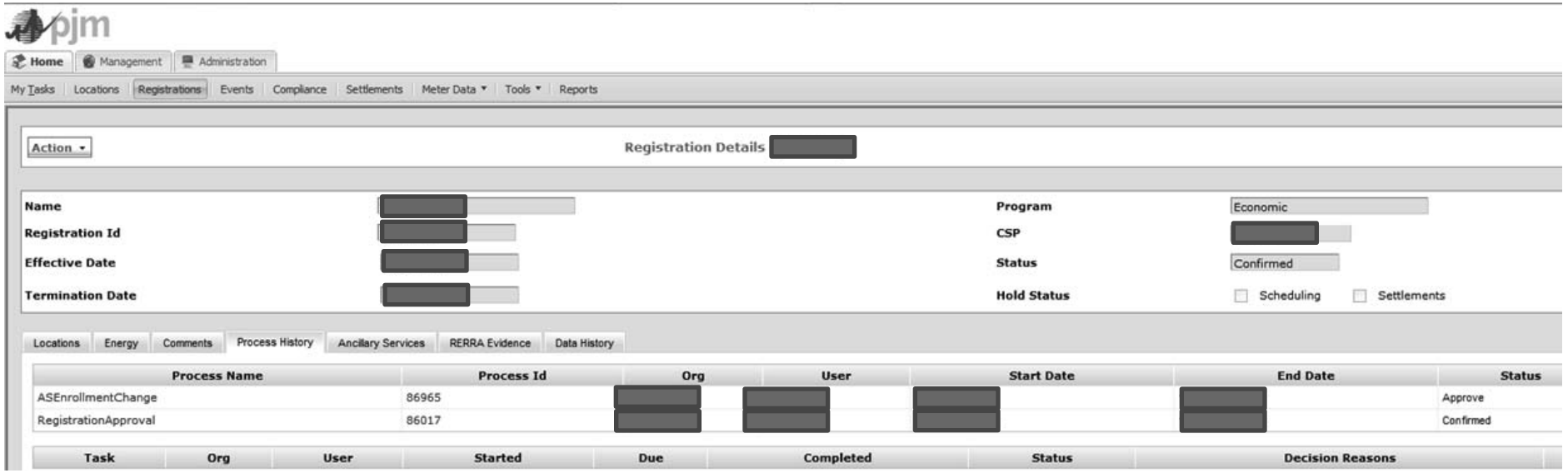
1. Under the Action button of the confirmed registration, select Request AS Enrollment Change

Request Day Ahead Scheduling Reserve Participation in eLRS



2. Select Day-ahead Scheduling Reserve

Request Day Ahead Scheduling Reserve Participation in eLRS



3. A task is created for PJM to review the prerequisites for synchronized reserve participation
   - The task can be seen under the Process History tab with the process name of ASEnrollmentChange
   - The Status shows the results of the PJM review
     - Pending
     - Approved
     - Denied

Prerequisites for Day Ahead Scheduling Reserve Participation

- Once Synchronized Reserve participation is requested, a task is created in eLRS for PJM to coordinate prerequisites with the CSP. Once the prerequisites have been fulfilled, then the registration is certified for Synchronized Reserve participation. The prerequisites for synchronized reserve participation include:

  1. The DSR resource must have a minimum DASR capability of 0.1 MW

Prerequisites for Day Ahead Scheduling Reserve Participation

2. One Minute interval metering is required. CSP must provide a brief description of the meter installation process and quality assurance plan as it relates to the new DSR rules found in PJM Manual 11 (Scheduling Operations), Section 10.6 "Interval Meter Equipment and Load Data Requirements" (how CSP ensures that the meter equipment is accurately recording electricity consumption once it is operational and how CSP ensures accuracy overtime)
   - http://www.pjm.com/documents/~/media/documents/manuals/m11.ashx

3. Complete the meter qualification form. If CSP has completed a prior version of this form for the location, then re-submittal is not necessary. CSP can put all registrations and associated locations (EDC account numbers) on one form. A copy of the form can be located at the following link:
   - http://www.pjm.com/markets-and-operations/etools/~/media/etools/elrs/20090904-dsr-customer-ownder-meter-qualification-form.ashx

Prerequisites for Day Ahead Scheduling Reserve Participation

4. CSP needs to send an email with an attached meter data file to dsr_ops@pjm.com for PJM to review
   - The email needs to specify a registration's name and number for submitted meter data. The file needs to include 24 hours of one minute interval readings from the CSP owned Customer Meter and EDC Meter readings (at any interval) for the corresponding 24 hours. In case a registration does not have an interval EDC meter, a copy of the customer's a monthly electric bill can be submitted instead. In this case one minute data needs to be submitted for the same period of the time as it shown on the bill. The meter file should include a registration number and units of measure
   - Template for submitting the 1 – minute meter data:
   - http://www.pjm.com/markets-and-operations/etools/elrs/~/media/etools/elrs/elrs-synchronized-reserve-meter-data-submission-template-20101103.ashx

CSP Resources

- For Portfolios and bidding
  - eMKT User Guide
- For Business Rules
  - PJM Manual 11:
  - http://www.pjm.com/~/media/documents/manuals/m11.ashx
  - Section 4.1 and 4.2
- For Day Ahead Scheduling Reserve Accounting
  - Operating Agreement Accounting - PJM Manual 28:
  - http://www.pjm.com/~/media/documents/manuals/m28.ashx
  - Section 19

Agenda

- Regulation Market
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- **Day Ahead Scheduling Reserve Market**
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  - **DASR Participation through eMKT**
  - DASR Monitoring and Verification

DSR Day Ahead Scheduling Reserve Participation through eMKT

- DSR registrations that are certified for Day Ahead Scheduling Reserve (DASR), participate in the Day Ahead Scheduling Reserve market through eMKT. DSR registrations must be available in the Day Ahead Economic Energy market in order to clear in the Day Ahead Scheduling Reserve market

- The following pages in eMKT must be completed in order to clear in the Day Ahead Scheduling Reserve Market

DSR DASR Participation through eMKT

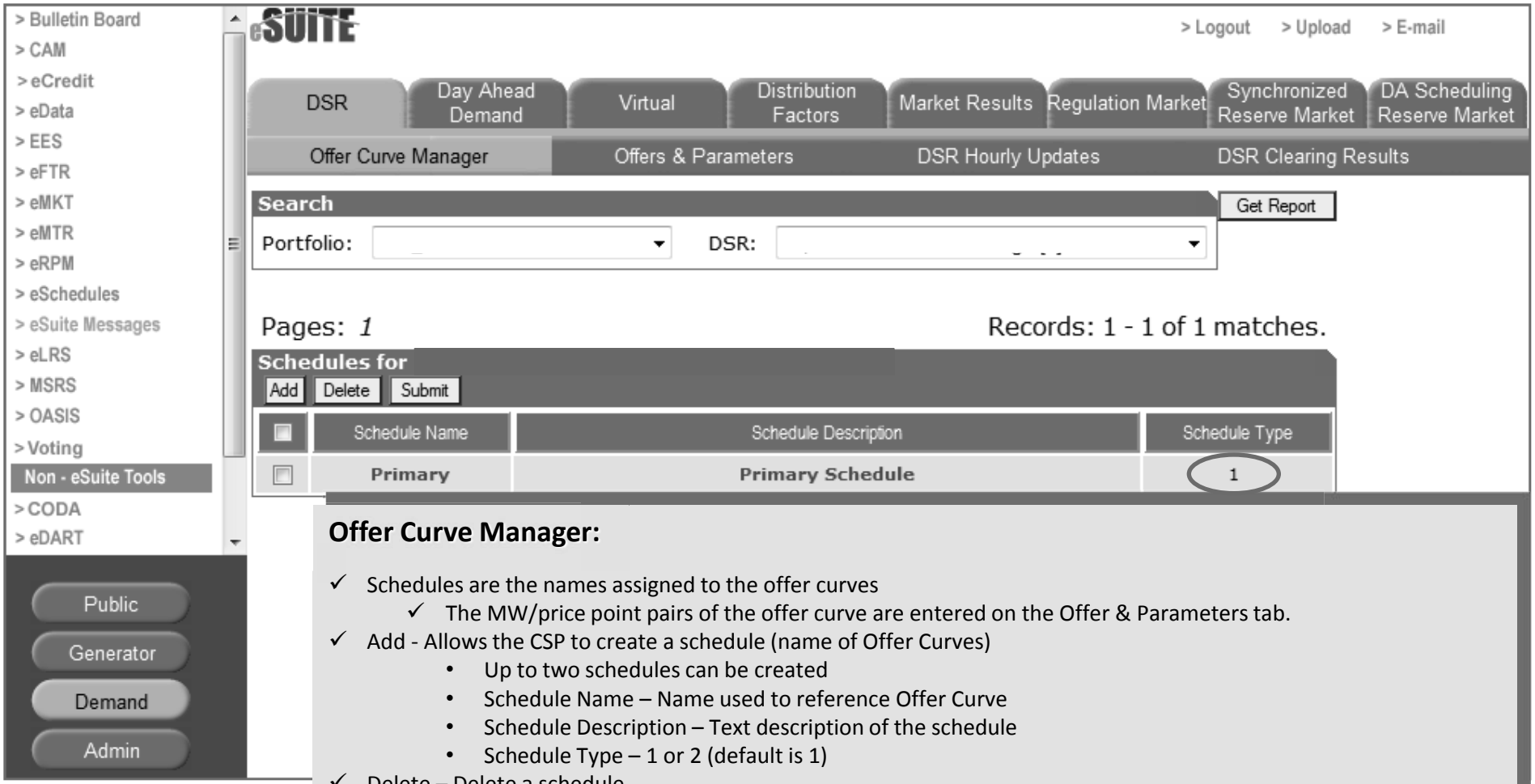
- Requirements to Participate in the DASR Market:

    1. The DASR market works in conjunction with the Day Ahead energy market and requires DSR Hourly Updates for each hour of DASR participation. Economic Max MW must be greater than Economic Min MW. The MW quantity of Day-Ahead Scheduling Reserves that a particular resource can provide in a given hour will be determined based on the energy Offer Data submitted in the Day-ahead Energy Market. The PJM engine for the Day Ahead market optimizes the MW cleared for Day Ahead energy and Day Ahead Scheduling Reserves
        - CSP does not enter DASR Offer MW

2. Participating in the DASR Market requires a Schedule Offer for the Day Ahead Energy market

3. DASR Offer Price is entered under the DA Scheduling Reserve Market / DA Scheduling Reserve Offers page

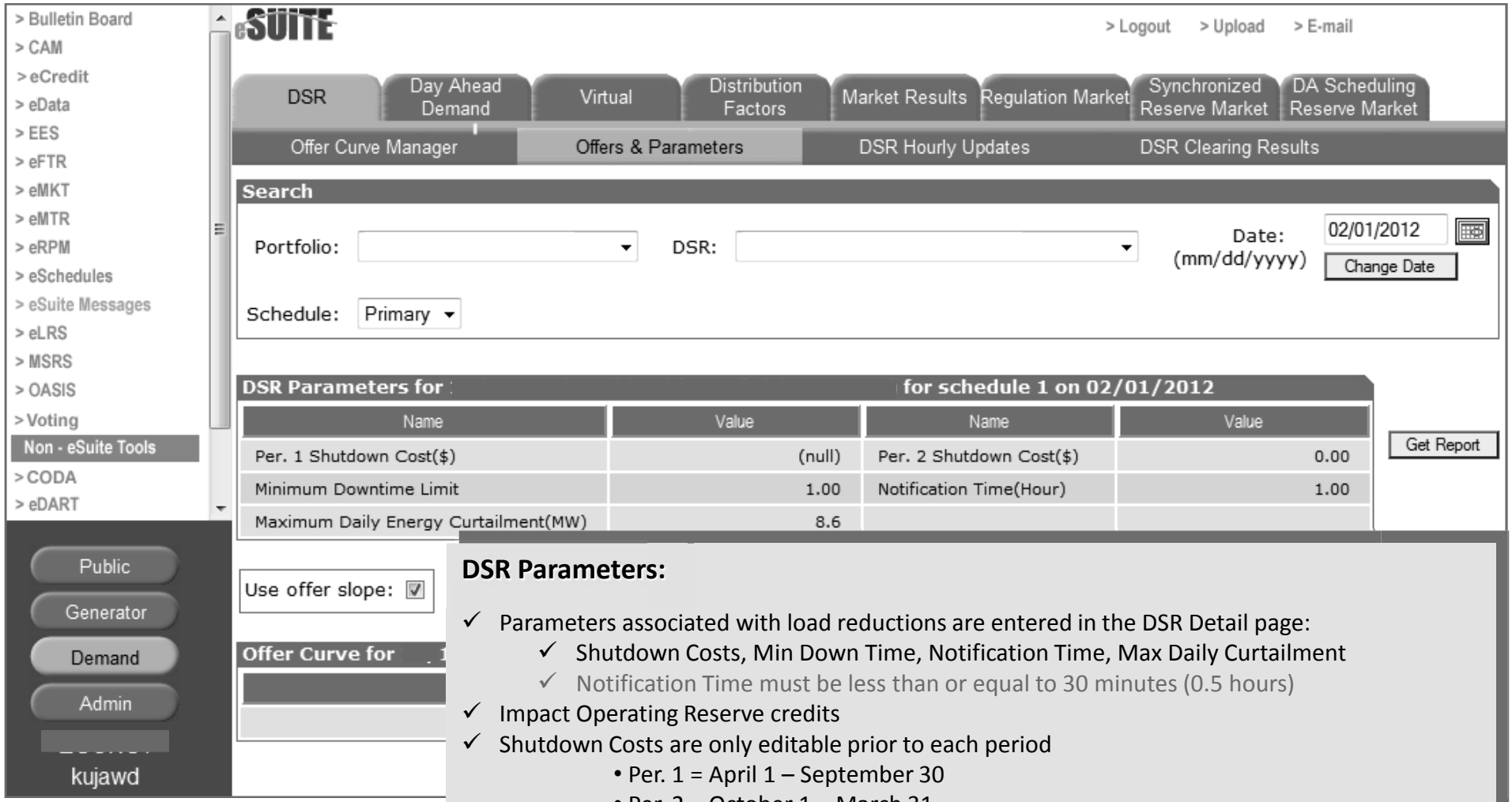
DSAR Requires - Offer Curve Manager - Schedules



Offer Curve Manager:

- ✓ Schedules are the names assigned to the offer curves
  - ✓ The MW/price point pairs of the offer curve are entered on the Offer & Parameters tab.
- ✓ Add - Allows the CSP to create a schedule (name of Offer Curves)
  - Up to two schedules can be created
  - Schedule Name – Name used to reference Offer Curve
  - Schedule Description – Text description of the schedule
  - Schedule Type – 1 or 2 (default is 1)
- ✓ Delete – Delete a schedule
- ✓ Submit – Submit the results of adding or deleting a schedule
- ✓ Add, Delete or Submit is not permitted when market is closed

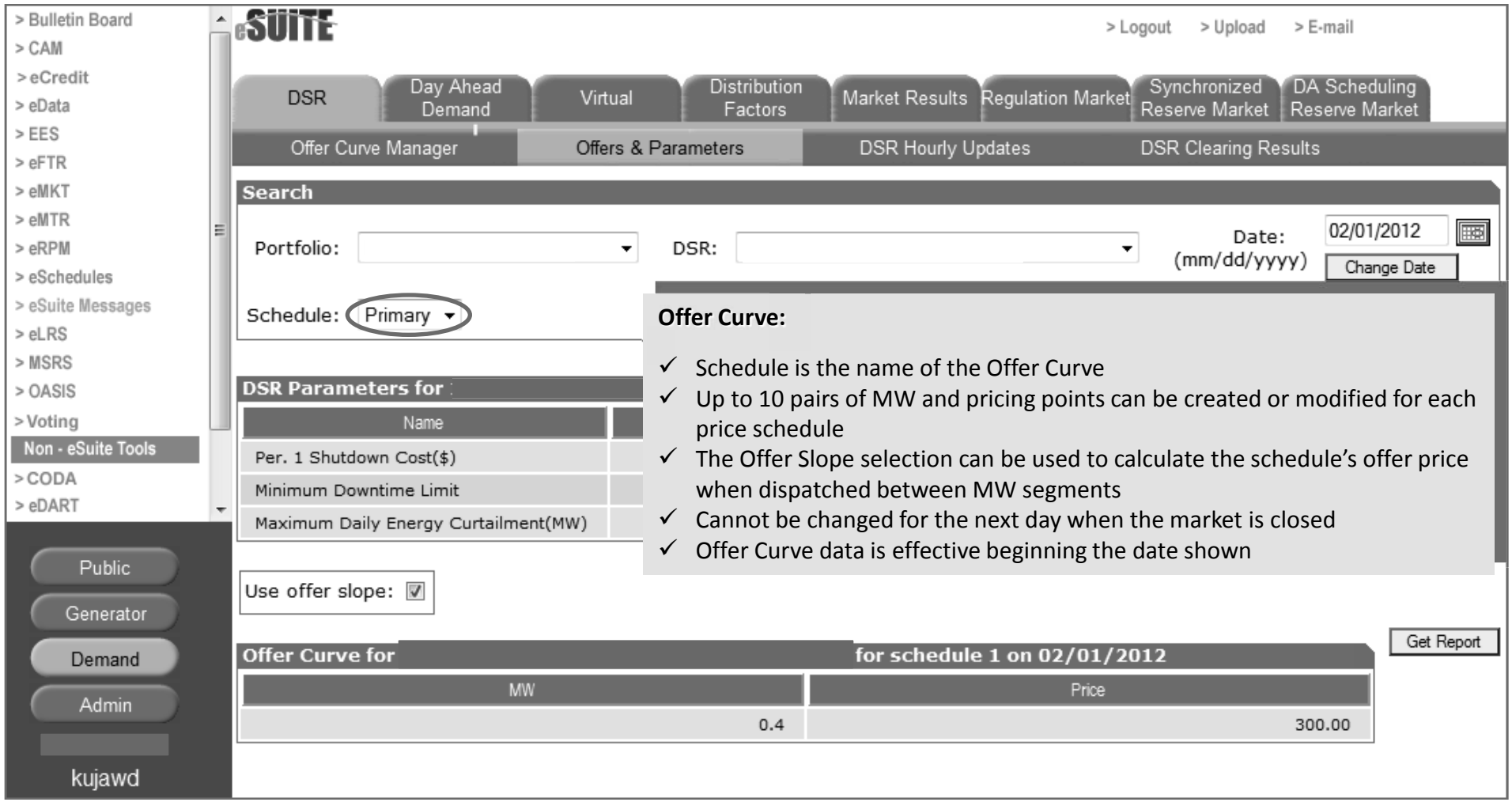
DASR Requires - DSR Parameters and Offer Curve



DSR Parameters:

- ✓ Parameters associated with load reductions are entered in the DSR Detail page:
  - ✓ Shutdown Costs, Min Down Time, Notification Time, Max Daily Curtailment
  - ✓ Notification Time must be less than or equal to 30 minutes (0.5 hours)
- ✓ Impact Operating Reserve credits
- ✓ Shutdown Costs are only editable prior to each period
  - Per. 1 = April 1 – September 30
  - Per. 2 = October 1 – March 31
- ✓ Parameters are effective beginning the date shown

DASR Requires - DSR Parameters and Offer Curve



Offer Curve:

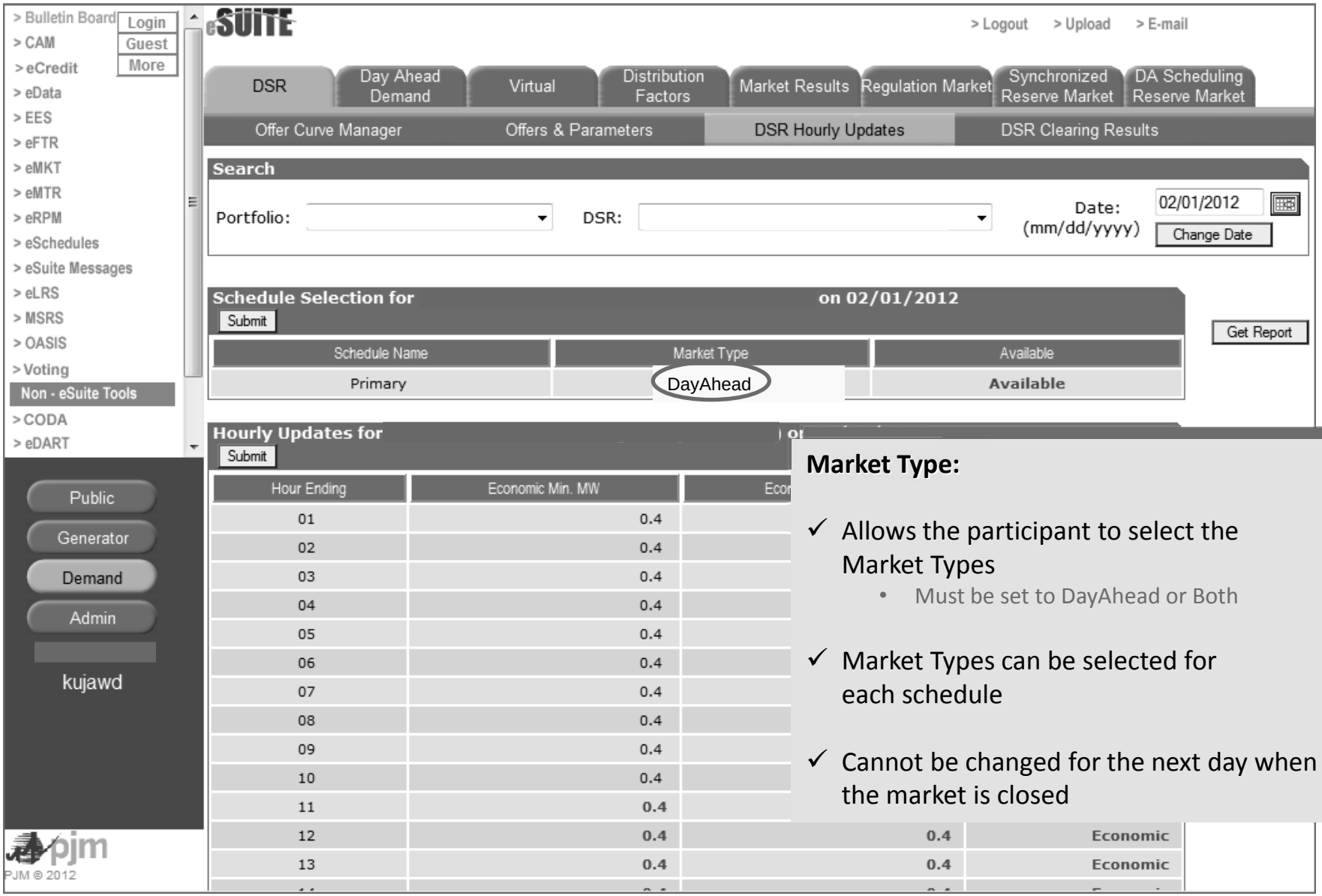
- ✓ Schedule is the name of the Offer Curve
- ✓ Up to 10 pairs of MW and pricing points can be created or modified for each price schedule
- ✓ The Offer Slope selection can be used to calculate the schedule's offer price when dispatched between MW segments
- ✓ Cannot be changed for the next day when the market is closed
- ✓ Offer Curve data is effective beginning the date shown

DASR Requires - Schedule Selection and Hourly Updates

- The DSR Hourly Updates page contains the Schedule Selection which is used in the Energy Market and is required for the DASR Market. The Schedule Selection defines the Market Type and availability used for economic participation. To participate in the DASR Market, there must be one schedule available and the Market Type must be set to either "DayAhead" or "Both"

  - DayAhead – participate in the Day Ahead Market
  - Both – can participate in both the Day Ahead and Balancing Markets

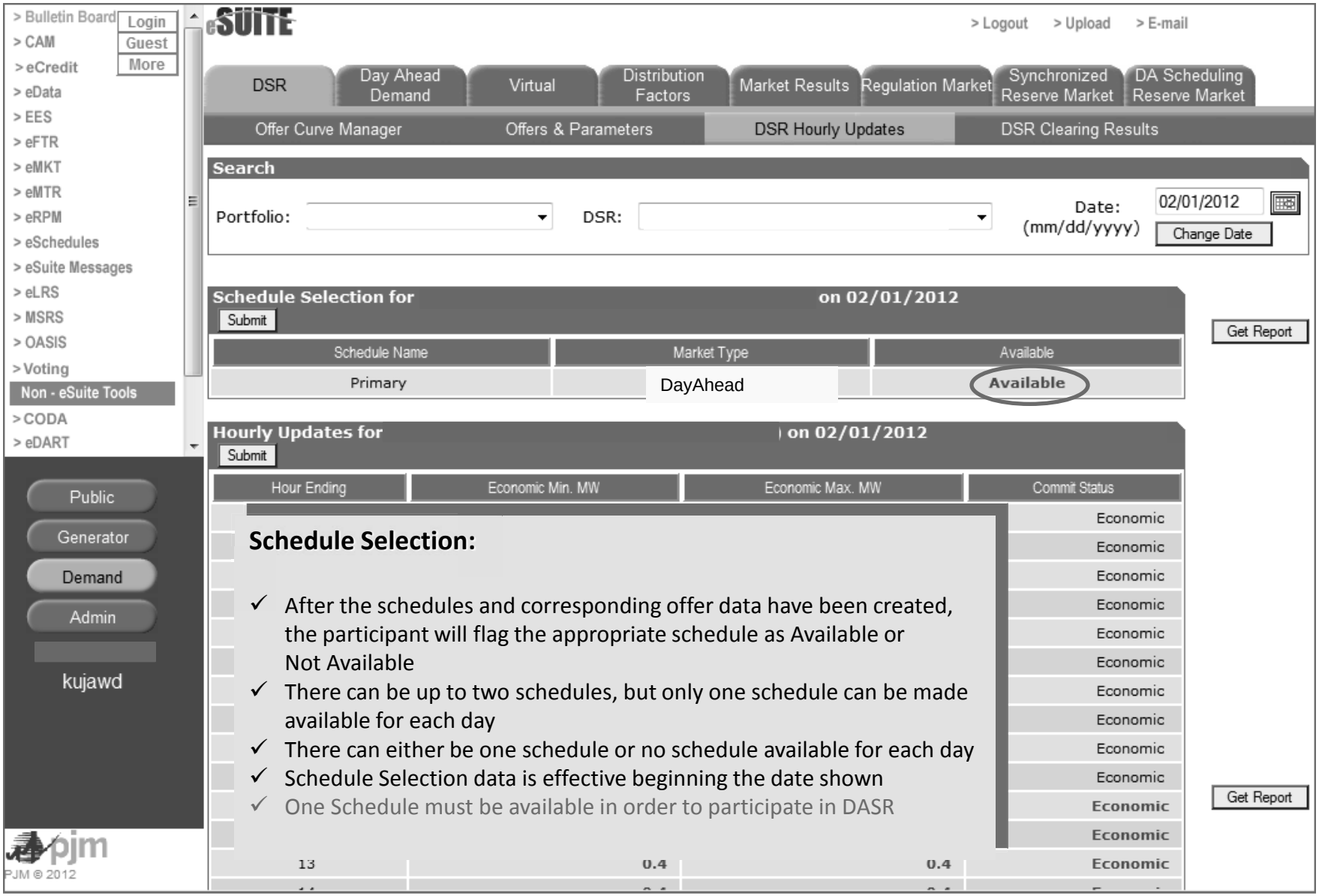
DASR Requires - Schedule Selection and Hourly Updates



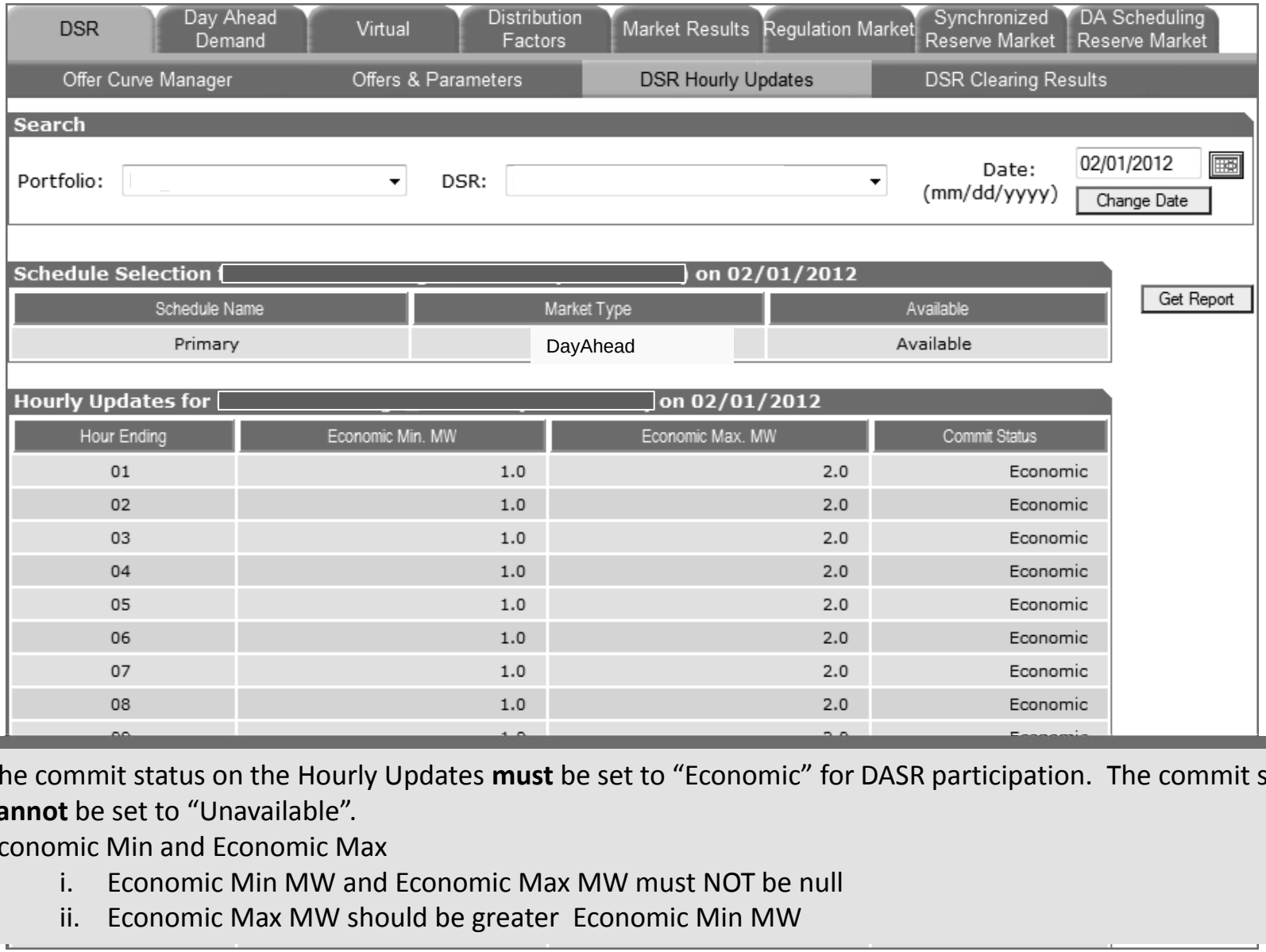
Market Type:

- ✓ Allows the participant to select the Market Types
  - Must be set to DayAhead or Both
- ✓ Market Types can be selected for each schedule
- ✓ Cannot be changed for the next day when the market is closed

DASR Requires - Schedule Selection and Hourly Updates



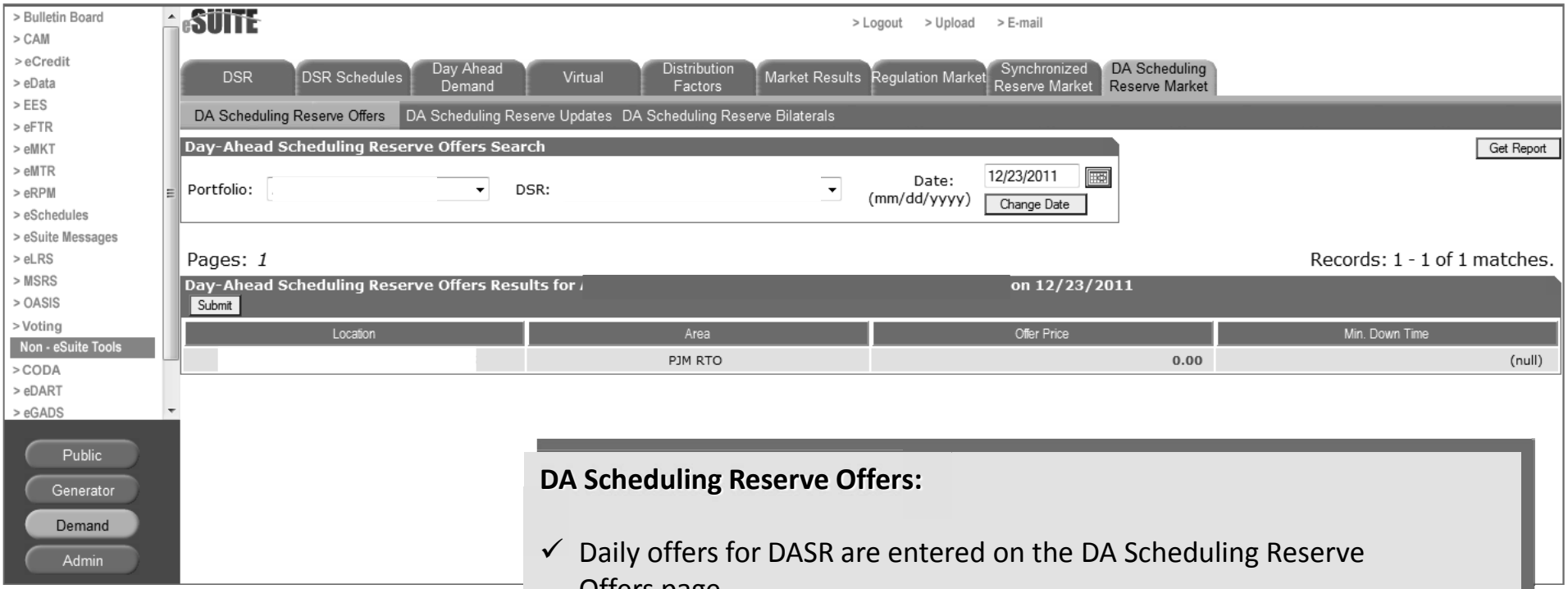
DASR Requires - Schedule Selection and Hourly Updates



a. The commit status on the Hourly Updates **must** be set to "Economic" for DASR participation. The commit status **cannot** be set to "Unavailable".

b. Economic Min and Economic Max
   i. Economic Min MW and Economic Max MW must NOT be null
   ii. Economic Max MW should be greater Economic Min MW

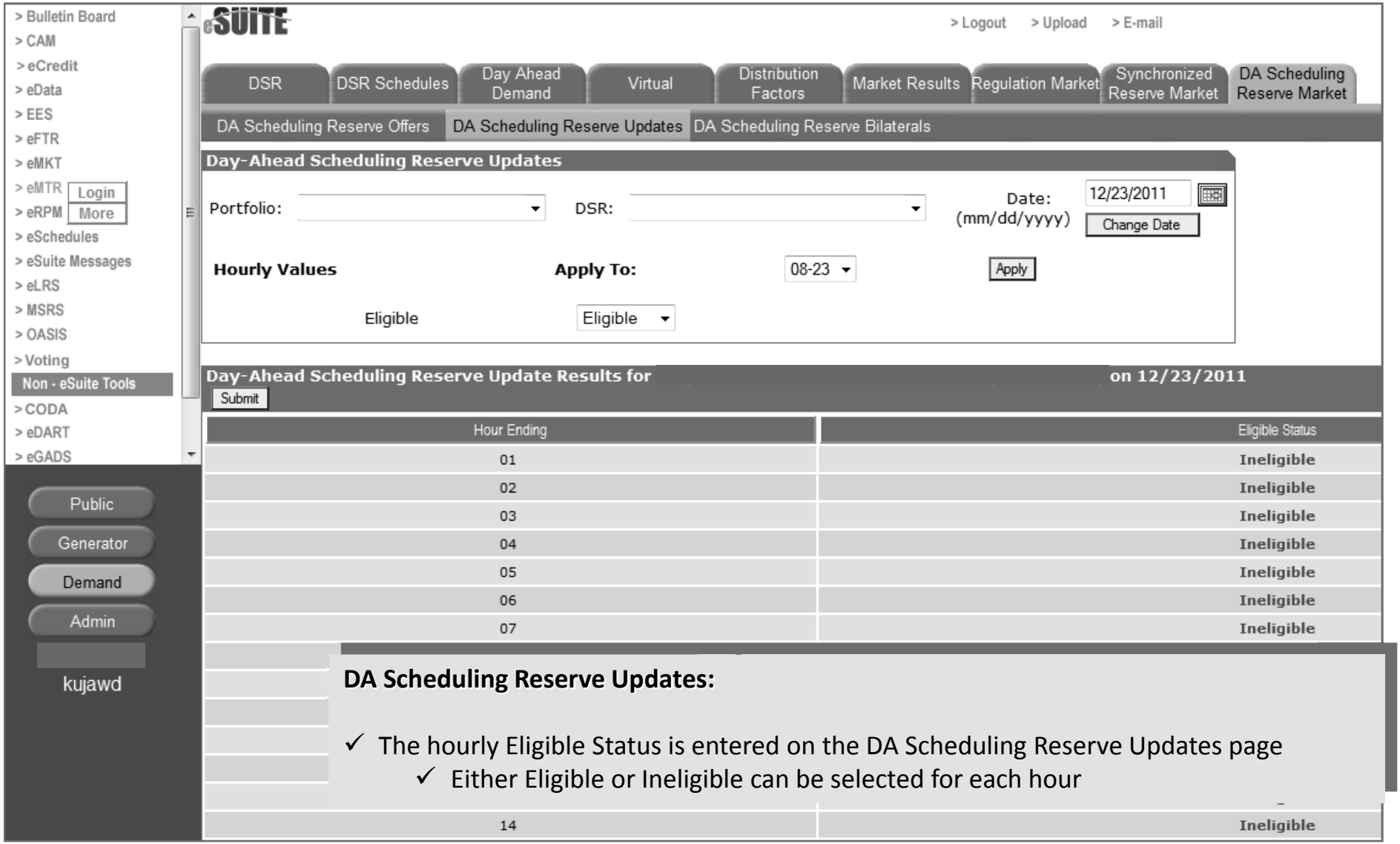
DA Scheduling Reserve Market/DA Scheduling Reserve Offers



DA Scheduling Reserve Offers:

- ✓ Daily offers for DASR are entered on the DA Scheduling Reserve Offers page
- ✓ Offer Prices ($) for DASR market offers need to submitted by 6PM **prior** to the operating **day**

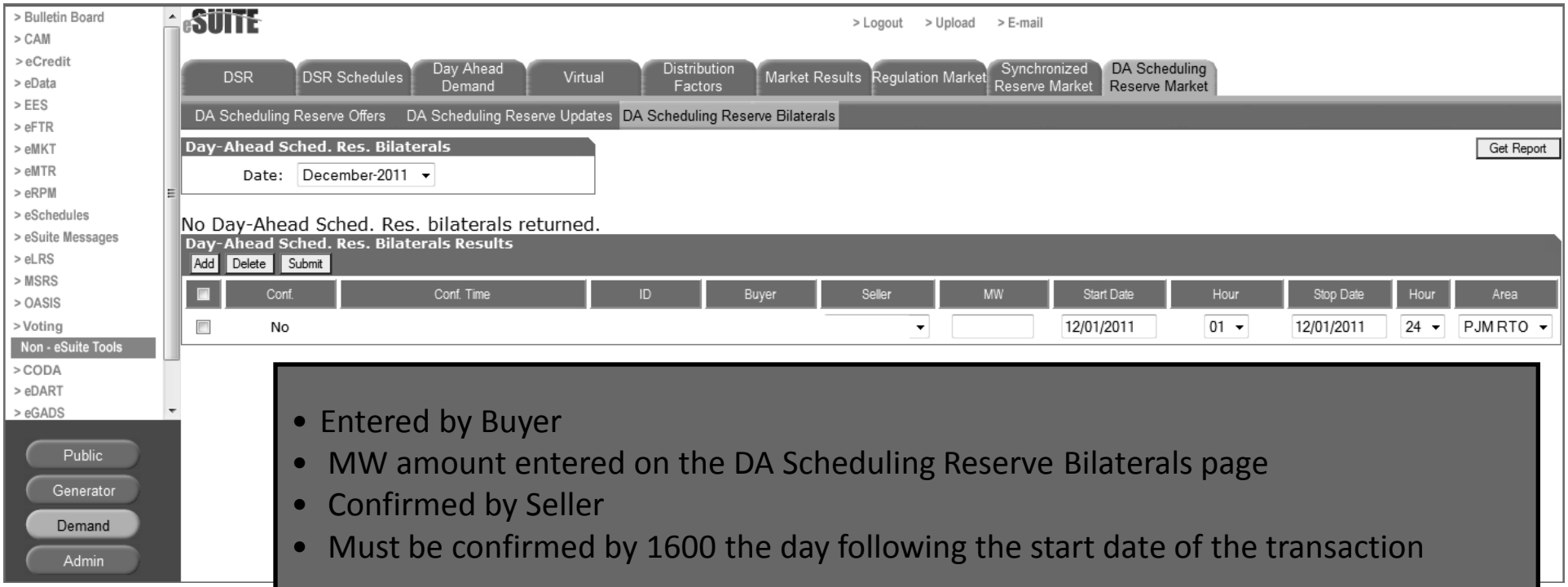
DA Scheduling Reserve Market/DA Scheduling Reserve Updates



DA Scheduling Reserve Updates:

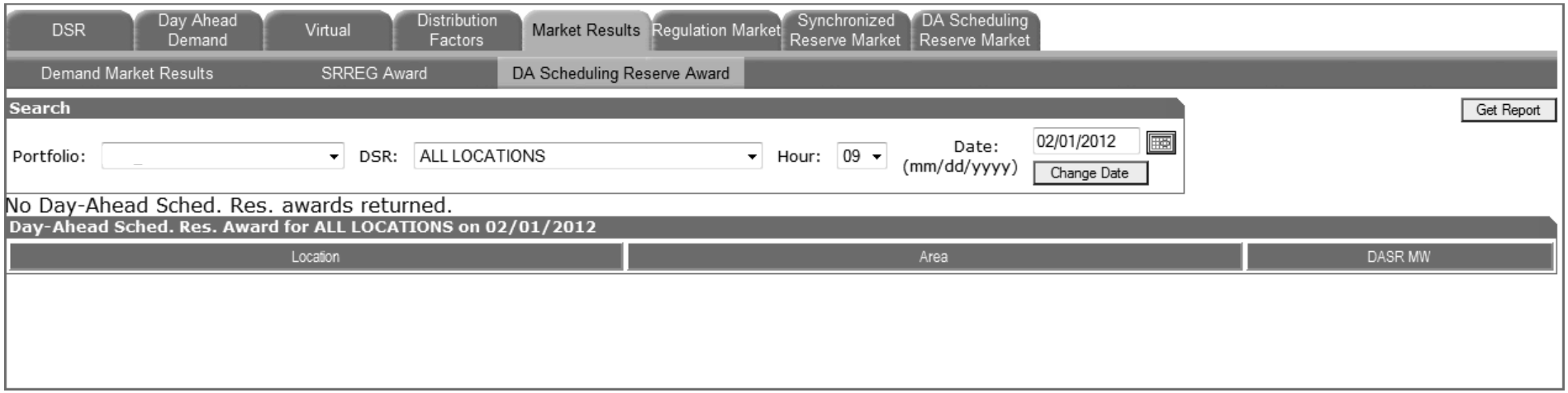
- ✓ The hourly Eligible Status is entered on the DA Scheduling Reserve Updates page
  - ✓ Either Eligible or Ineligible can be selected for each hour

DA Scheduling Reserve Bilateral Transactions



- Entered by Buyer
- MW amount entered on the DA Scheduling Reserve Bilaterals page
- Confirmed by Seller
- Must be confirmed by 1600 the day following the start date of the transaction

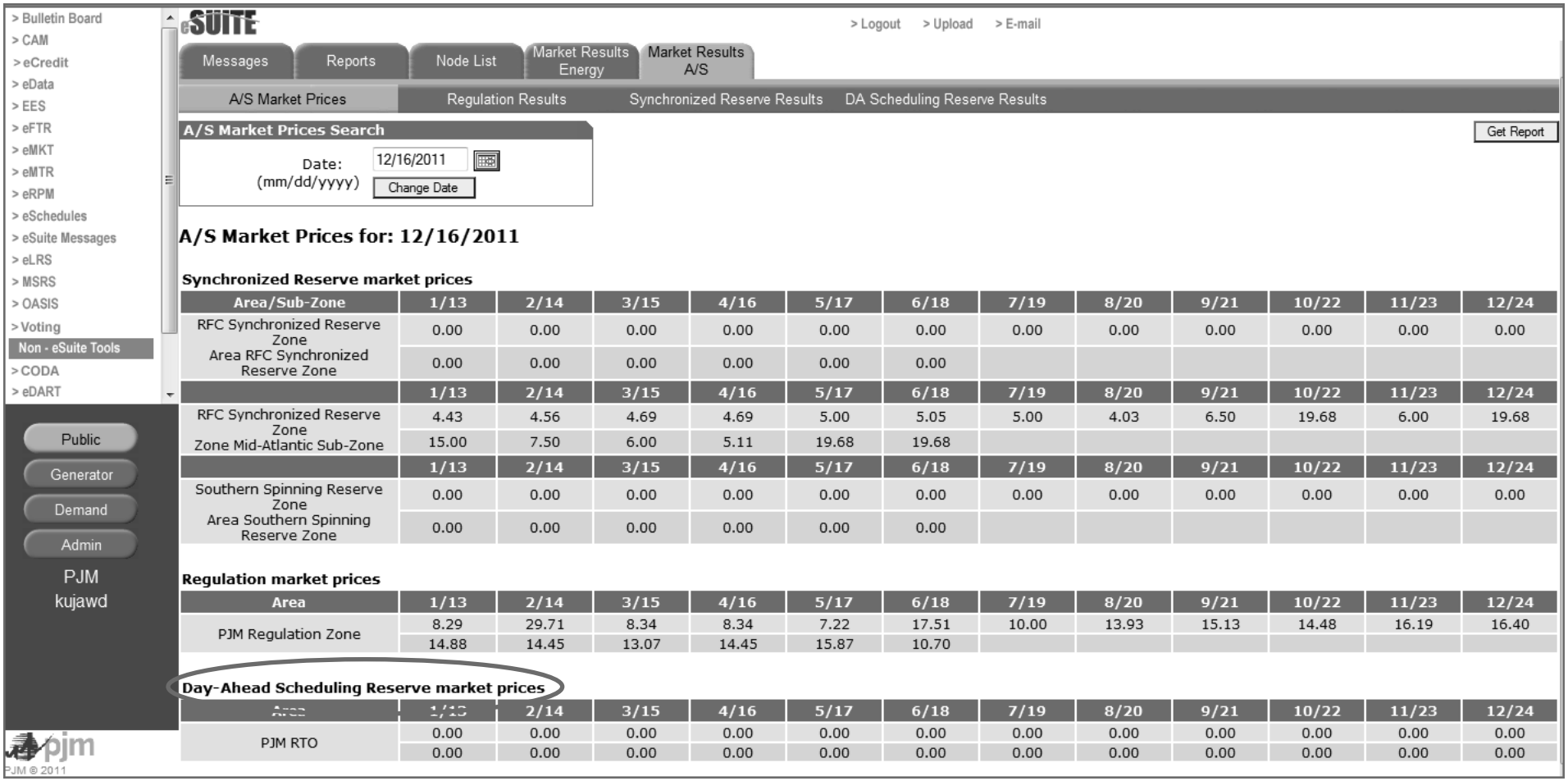
DA Scheduling Reserve Market Results – Private



Cleared DASR Offers are posted at the same time as the Day Ahead Market results

- Day before the operating day by 16:00
- DA Scheduling Reserve Award page

DA Scheduling Reserve Market Results – Public

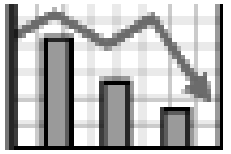


Agenda

- Regulation Market
- Synchronized Reserve Market
- **Day Ahead Scheduling Reserve Market**
  - Market-based Day Ahead Scheduling Reserve Overview
  - Request DASR Participation in eLRS
  - DASR Participation through eMKT
  - **DASR Monitoring and Verification**

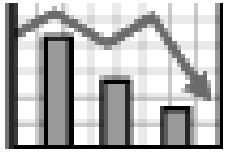
DASR Response Calculation / Verification

- Resource responses are verified by the PJM Performance Compliance Dept following each event
- Metering data to be submitted via eLRS on one day lag
  - One minute meter data is submitted in eLRS through Meter Data Management tab
  - An Excel template used to submit the 1 minute meter data is located on the PJM website. Select Markets & operations/eTools/eLRS and then selecting the Excel file called “Meter Data Example Ancillary Services”
  - 10 minutes of data is recommended prior to start of event and after end of event



DASR Response Calculation / Verification

- DASR compliance is measured when a real-time dispatch instruction coincides with a cleared DASR hour. DASR compliance is measured as the difference between the resource‘s meter reading at the start of the dispatch instruction and its meter reading 30 minutes after the dispatch instruction
  - In order to allow for small fluctuations and possible delays, resource meter readings at the start of the event is defined as the greatest metered output between one minute prior to and one minute following the start of the dispatch instruction. Similarly, a resource‘s meter reading 30 minutes after the dispatch instruction is defined as the lowest meter reading achieved between twenty nineand thirty one minutes following the start of the dispatch instruction



DASR Monitoring and Verification – Batch Load

Registration consuming at the start of a dispatch instruction

- If a registration that is a Batch Load resource is cleared for DASR is consuming energy at the start of a dispatch instruction from PJM to reduce load, the registration shall respond by reducing load as quickly as it is capable and by keeping its consumption at or near zero megawatts for the entire length of the dispatch instruction. DASR compliance is measured as defined in the bullet above

Registration with reduced consumption at the start of a dispatch instruction

- If a registration that is a Batch Load resource is cleared for DASR has reduced its consumption of energy for its production processes to minimal or zero megawatts prior to the start of a dispatch instruction from PJM to reduce load, the registration shall respond by reducing load as quickly as it is capable, delaying the restart of its production processes, and keeping its consumption at or near zero megawatts for the entire length of the dispatch instruction
  - Compliance is measured as the MW difference between the ending MW usage and the highest MW usage within 10 minutes after the end of the dispatch instruction
    - Remaining 9 minutes of usage within the 10 minute period must not be less than 50% of the highest usage

Penalties

- No penalties exist for DASR noncompliance
- Forfeiture of DASR revenue over hours assigned for the day