Overview of PJM Demand Response and Energy Efficiency in Capacity and Ancillary Services Markets

10/21/09
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Roles of PJM Market Participants

Load Serving Entity:

PJM Member, including Load aggregator or power marketer, serving end-users within the PJM Control Area, to sell electric energy to end-users with the PJM Control Areas.

Generator:

PJM Member that owns, or leases, facilities for generation of electric energy that are located within the PJM Control Areas.

End Use Customer

Curtailment Service Provider:

PJM Members that is responsible for demand response resources comprised of end-use customers.

Electric Distribution Company :

PJM Member that owns, or leases, electric distribution facilities that are used to provide electric distribution service to electric load within the PJM Control Areas.

- Demand Side Response (DSR) – ability to shift or reduce load in response to price or signal by PJM
- Energy Efficiency (EE) – investment in assets, not mandated by government codes and standards, which results in a sustained net decrease in energy and demand usage.
- Price Responsive Demand (PRD)* – dynamic retail prices with supervisory control on device that have predictable impact on capacity requirement

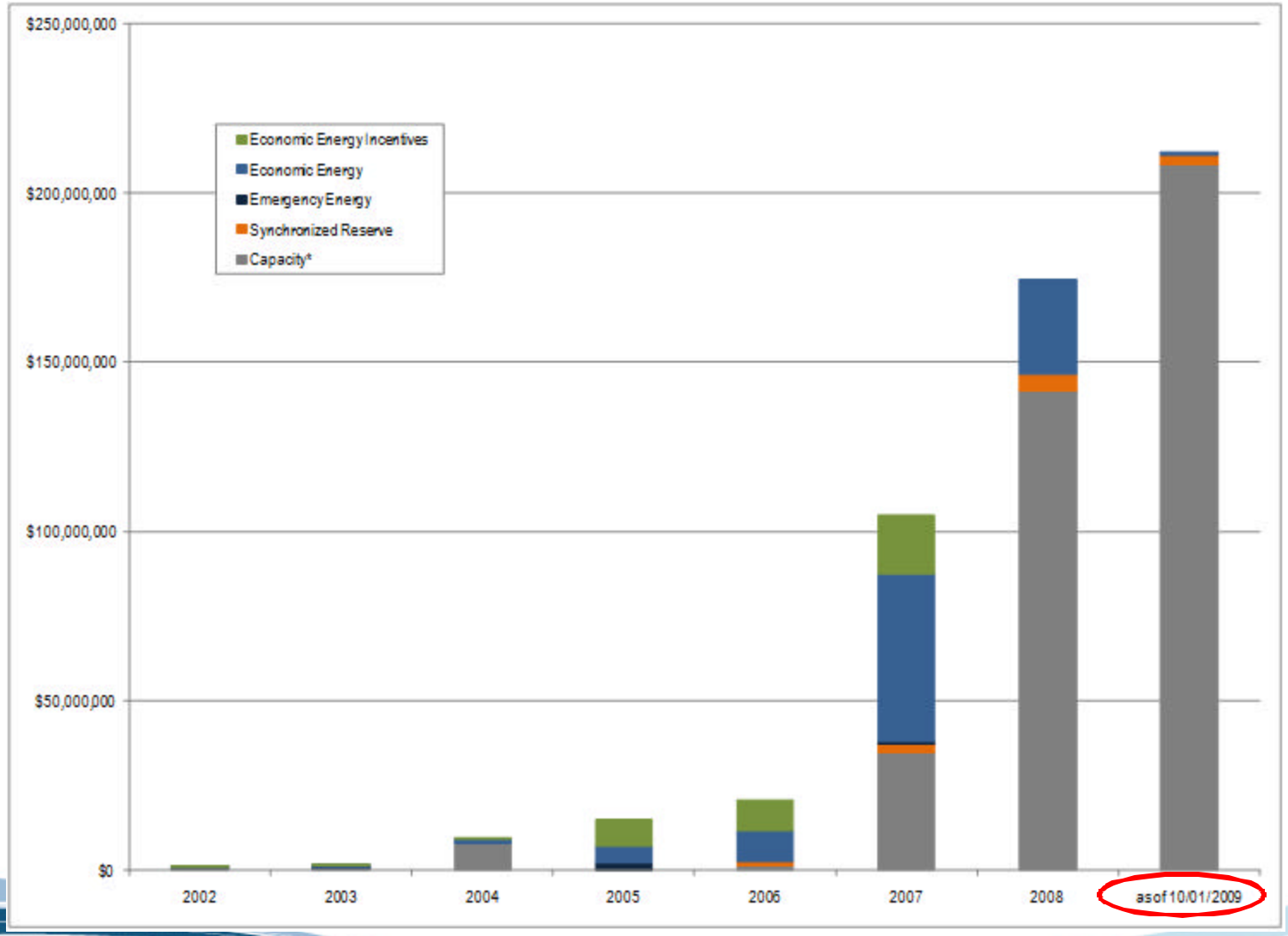
*PRD is a work in a progress and has not yet been adopted by stakeholders and implemented.

PJM Opportunity by Wholesale Market

Focus Today

Wholesale Service	Demand Side Response	Energy Efficiency	Price Responsive Demand *
Capacity	Yes	Yes	Yes (reduction in forecasted capacity requirement)
Energy	Yes		
Day Ahead Scheduling Reserves (30 min)	Yes		
Sychronized Reserves (10 min)	Yes		
Regulation	Yes		

Demand Side Response estimated annual revenue



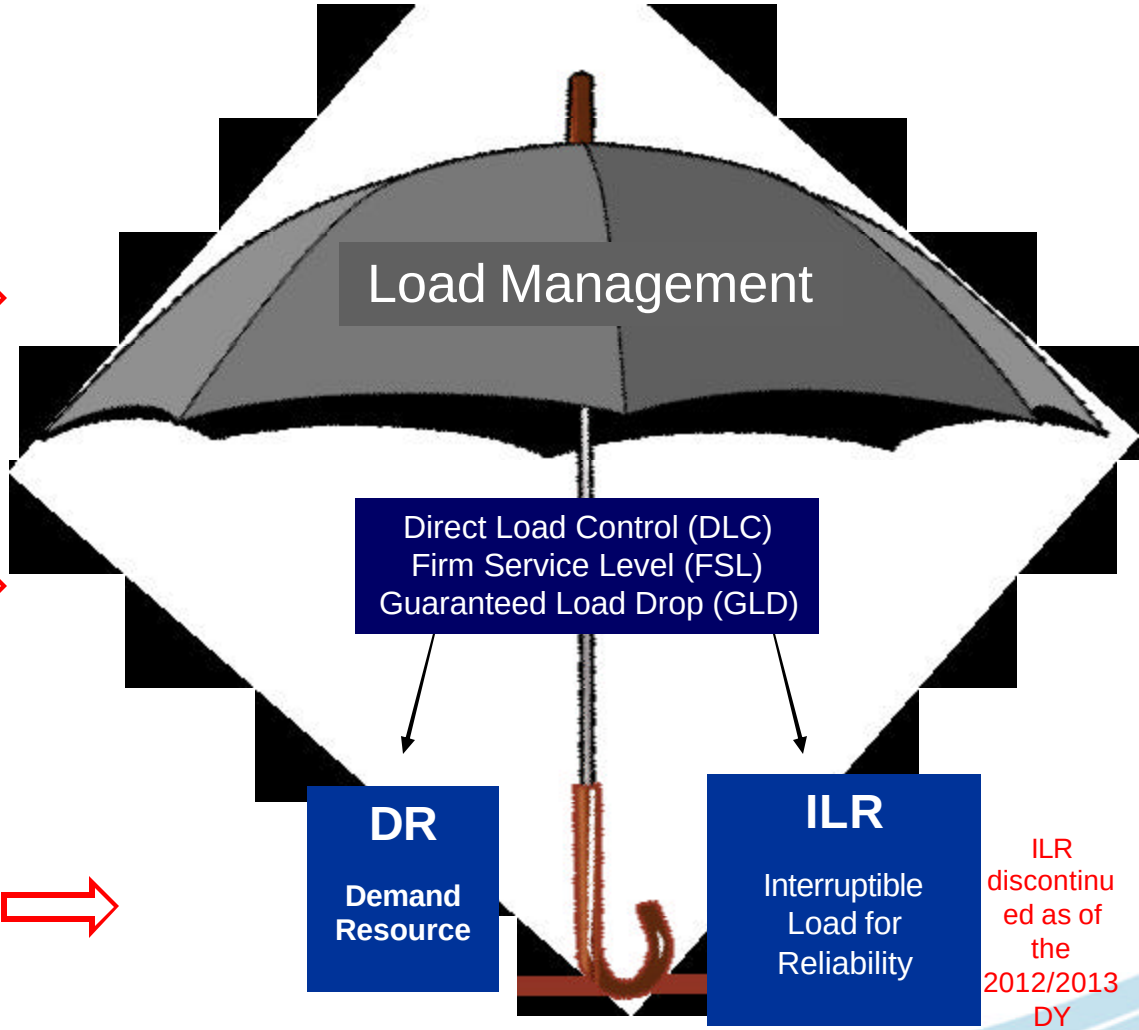
*Capacity revenue prior RPM implementation on 6/1/07 estimated based on average daily ALM capacity credits and weighted average daily PJM capacity market clearing price.

PJM Terminology (Emergency Program)

Load Management is the broad term to describe load that responds to PJM emergencies

DLC, FSL, & GLD are the different types of Load Management

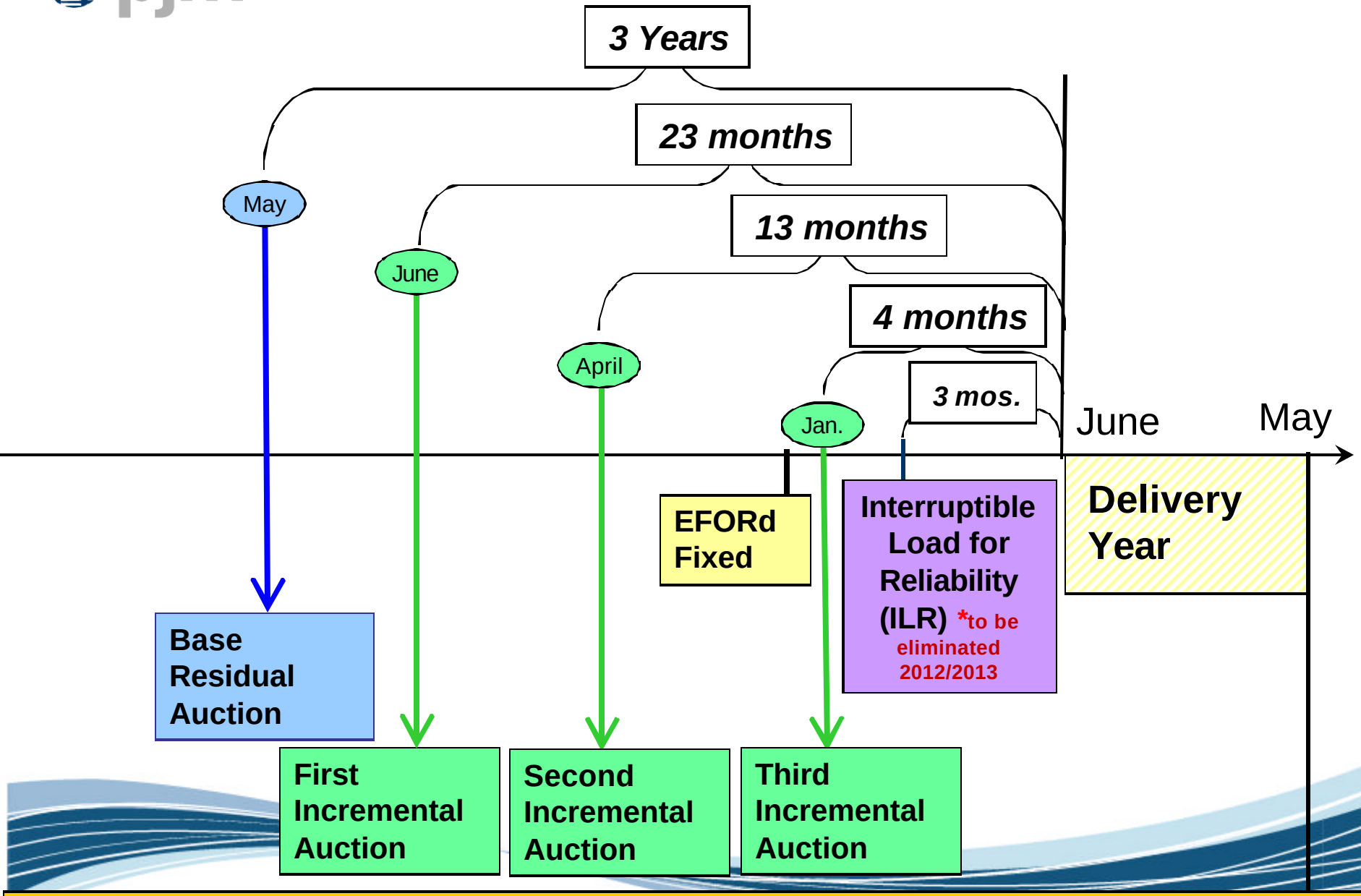
DR & ILR are the options to participate in the Reliability Pricing Model (RPM)



Note: Energy Efficiency is not dispatchable and therefore not considered Load Management

- Emergency Program (Capacity and Energy)
  - Mandatory
    - Penalties for non-performance
  - Load Management (ILR or DR)
    - DR participates directly in RPM auction
    - ILR nominate 3 months prior to delivery year & will not be available after the '11/'12 delivery year.
  - Quantity tied to retail peak load contribution (PLC)
  - Interval metering required
  - Non-interval metering for direct load control
    - Non-interval meter pilot available
  - Load reduced is incorporated back into forecast requirement for next year (Aka - "add back")

Current RPM Timeline



Ongoing Bilateral Market

Load Management (ILR/DR) Commitment

- Availability for up to ten (10) PJM-initiated interruptions at any time during the planning period.
- Interruptions of up to six (6) consecutive hours' duration between 12:00 PM (Noon) to 8:00 PM (Eastern Prevailing Time) for the months of May through September and 2:00 PM to 10:00 PM for the months of October through April, on weekdays other than PJM Holidays.
- Load management must be able to be implemented within two hours (2) of notification to the resource provider of a PJM-initiated load management event.
  - Participant will specify either one or two hours during registration process
- Initiation of load interruptions upon request of PJM must be within the authority of the resource provider dispatcher without any additional approvals being required.

Load Management (ILR/DR) Revenue & Penalties

- Example Revenue
  - Curtailment MWs * RPM locational price (for appropriate auction)
    - 1 MW * $169.63 (DPL ’12/’13 BRA result) * 365 days = $61,916 revenue per year.
    - 1 MW * $16.46 (COMED ’12/’13 BRA result) * 365 days = $6,008 revenue per year.
- Penalties
  - DR deficiency charge – higher of 120% of revenue or weighted average price + $20 * volume for 0 compliance
  - Event Compliance – proportion of revenue based on number of events not to exceed total revenue
  - Test Compliance – higher of 120% of revenue or weighted average price + $20 * volume for 0 compliance

Energy Efficiency (EE) Definition

- Installation of more efficient devices or equipment or implementation of more efficient processes/systems exceeding building codes, appliance standards, or other relevant standards at the time of installation as known at the time of the commitment to the capacity market.

- Designed to achieve a continuous reduction in electric demand that is not reflected in the peak load forecast prepared for the Delivery Year.
  - Value of EE installation is measured during defined EE Performance Hours

- Fully implemented at all times during the Delivery Year, without any requirement of notice, dispatch, operator intervention.
  - If dispatchable, it would be considered a Demand Resource.

Effective Delivery Year for Offering EE

- EE Resource is eligible to be offered into an RPM Auction beginning with the 2012/2013 DY.
  - Base Residual Auctions
  - Incremental Auctions
- An EE Resource is not eligible to be offered into RPM Auctions or receive RPM Auction revenues prior to the 2012/13 DY.
- EE installations are eligible to receive Capacity Market (RPM) revenue for up to four consecutive Delivery Years.
- EE installation prior to June 2011 will not be eligible for a full four years of RPM revenue, since payments would not begin until 2012/2013.

- **Nominated EE Value is expected average demand reduction (MW) during the defined EE Performance Hours in the Delivery Year.**
  - EE Performance Hours are between hour ending 15:00 EPT and hour ending 18:00 EPT during all days from June 1 through August 31, inclusive, of such Delivery year, that is not a weekend or federal holiday.
- Measurement & Verification (M&V) Plan describes the method and procedures for determining the Nominated EE Value of an EE Resource and confirming the Nominated EE Value is achieved.
- The minimum Nominated EE Value accepted is 0.1 MW.

EE Resource Requirements

- ✓ Submit M&V Plan prior to RPM Auction
  - Single M&V Plan may be submitted to cover multiple EE Resources
  - Single M&V Plan must clearly document the Nominated EE Value of each EE Resource covered in the Plan
- ✓ Establish credit with PJM Credit Department prior to RPM Auction
- ✓ Submit Post-Installation M&V Reports
- ✓ Permit Post- Installation M&V Audit by PJM or Independent Third Party

- Revenue
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- Penalties
  - higher of 120% of revenue or weighted average price + $20 * volume for 0 compliance
    - Resource not available on-time
    - Change in M&V results or audit issue

Demand Response in Ancillary Service Markets

- Day ahead scheduling reserves (30 minute spin)
  - Must reduce net load within 30 minutes if dispatched by PJM
  - Hourly market price (DAMCP)
    - Average September 2009 ($0.02 mwh)
- Synchronized Reserves (10 minutes spin)
  - Reduce load during reserve shortage, must reduce net load within 10 minutes.
  - Hourly market price (SRMCP)
    - Average September 2009 (midatlantic = $7.50 mwh, Non-PJM midatlantic = $0.05 mwh)
- Regulation – real time load change (increase or decrease) based on real time system conditions
  - Hourly market price (RMCP)
    - Average September 2009 ($22.57 mwh)

Reliability service - must be there when system operator needs it.

Payments, Costs, & Risks

Ancillary Service Markets	Participation	Payment To DSR resource	Cost to Energy Market	Risks To DSR resource
Synchronized Reserves	**• Ten-minute reduction requirement** **• One-minute interval metering** **• Minimum .5 MW offer** **• 24-hour All-Call availability** **Tier 1**: Voluntary reduction during a PJM Synchronized Reserve event **Tier 2**: Offers that clear in hourly market. Mandatory reduction during PJM Synchronized Reserve event	**Tier 1**: PJM pays $50 premium above event LMP **Tier 2**: • PJM pays Synchronized Reserve Market Clearing Price (SRMCP) * MW assigned • ELRP payment for reduction during event ELRP = Economic Load Response Program	**Synchronized Reserve costs allocated to load servers:** **Tier 1**: • Based on percentage share of total Tier 1 credits paid **Tier 2**: • Based on obligation share	**Nonperformance:** **Tier 1**: No Penalties **Tier 2**: • Forfeiture of Tier 2 revenue over contiguous hours assigned • Additional obligation in the amount of shortfall for next three same-peak days
Regulation	**• 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 .5 MW offer** **• Resource certification and testing requirements**	• PJM pays Regulation Market Clearing Price (RMCP) * MW Assigned • ELRP payment net reduction during hour • Make-whole payment to cover offer ELRP = Economic Load Response Program	**Regulation costs allocated to load servers:** (RMCP * Adjusted Obligation) + Share of Opportunity Cost above RMCP	**Nonperformance for assigned Regulation resource:** • Forfeiture of revenue for assigned MW's • Periodic testing below 75% score requires re-certification process

Ancillary Service Markets	Participation	Payment To DSR resource	Cost to Energy Market	Risks To DSR resource
Day-Ahead Scheduling Reserves (DASR)	**• 30-minute reduction requirement** **• One-minute interval metering** **• Offer needs to be submitted in the PJM Day-Ahead Market** **• Load Response needs to be dispatched by PJM in Real TIme**	• PJM pays DASR Market Clearing Price * MW assigned	**DASR costs allocated to load servers:** (DASRCP * Adjusted Obligation) + Share of Opportunity Cost above DASRCP	**Nonperformance:** Forfeiture of revenue over hours assigned for the day

- PJM implementation of new demand response system (eLRS)
  - Provide electronic event notification
  - Facilitate aggregation
  - Improve transparency & workflow
  - Calculate customer baseline for energy market
- IRC (ISO/RTO) council effort on SMART grid standards
  - Demand Response is one of primary efforts
  - National Institute of Standard for Technology (NIST)
- NAESB M&V standard
  - Potential to expand and address additional technical requirements

- Reference Material
- Load Management revenue detailed calculation example
- Illustration of last load management during last PJM emergency event
- Energy Efficiency & RPM auction timeline

- Price Responsive Demand Paper (Paul Centolella and Andrew Ott)
  - http://www.hks.harvard.edu/hepg/Papers/2009/Centolella%20%20Ott%20PJM%20PRD%2003092009.pdf
- DSR Training Material

  http://www.pjm.com/training/training-material.aspx
- Key PJM Manuals
  - M18 (RPM Manual)
  - M18b (EE M&V manual)
  - M19 (M&V guidelines for DSR capacity including direct load control)
  - M11, section 10 (details on DSR participation)
- General DSR material
  - http://www.pjm.com/markets-and-operations/demand-response.aspx

Calculating Load Management Revenue - Example

Type		MW (PLC)		MW (GLD)	MW (FSL)		Capacity Loss Factor	MW (load reduction value)		FPR Factor	DR Factor	MW (Unforced Capacity)
FSL		28.5			10		1.0634	17.9		1.0796	0.958	18.5
		A			B		C	D = A-(B*C)		E	F	G=D*E*F
GLD		28.5		16.8			1.0634	17.9		1.0796	0.958	18.5
		A		B			C	D = B*C, where max = A		E	F	G=D*E*F

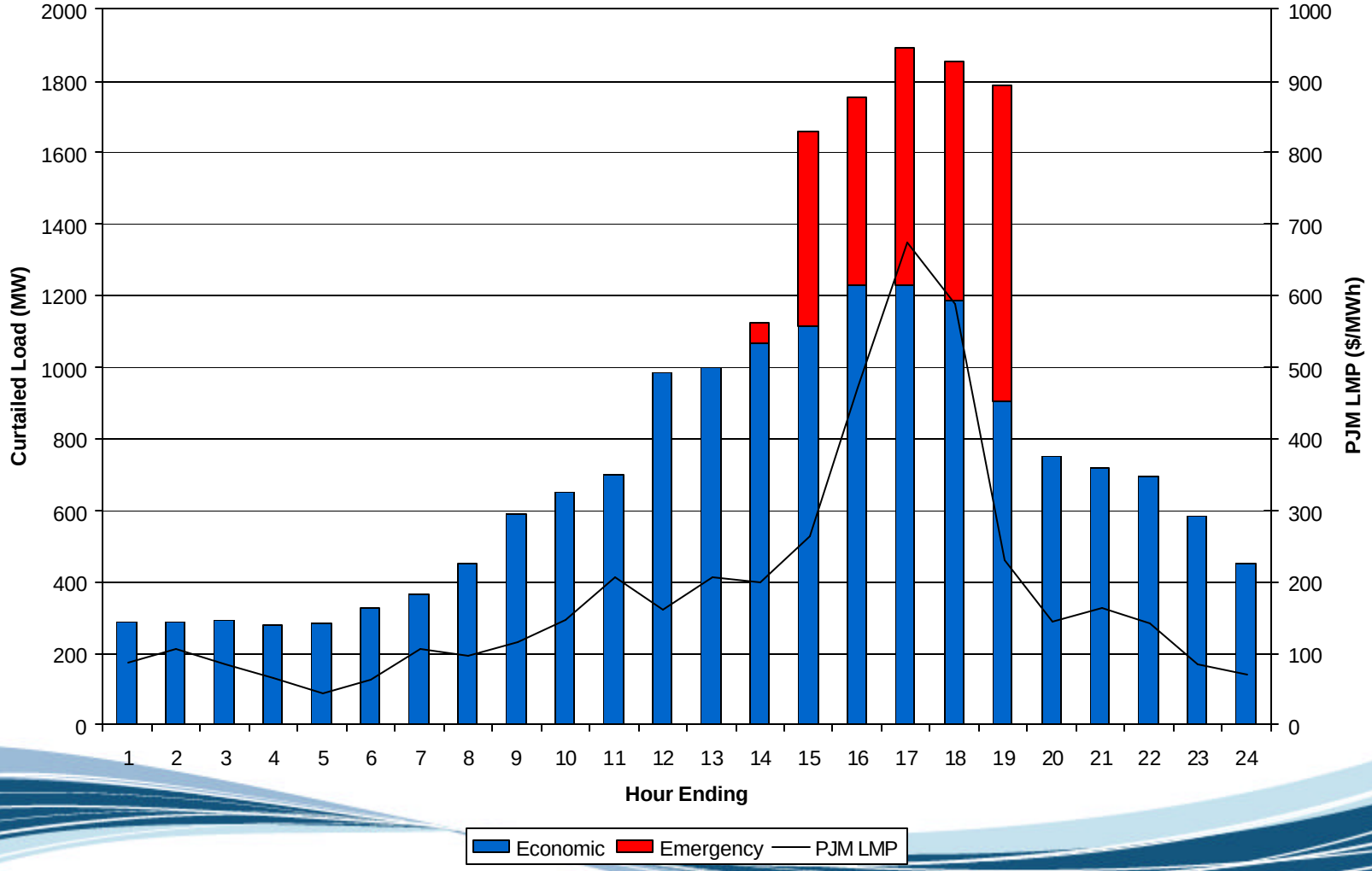
MW (Unforced Capacity)	Market Price (MW/Day)	Days/Year	$ (Annual Revenue)
18.5	210.11	365	$ 1,417,083

See PJM Web for appropriate Planning Year Parameters

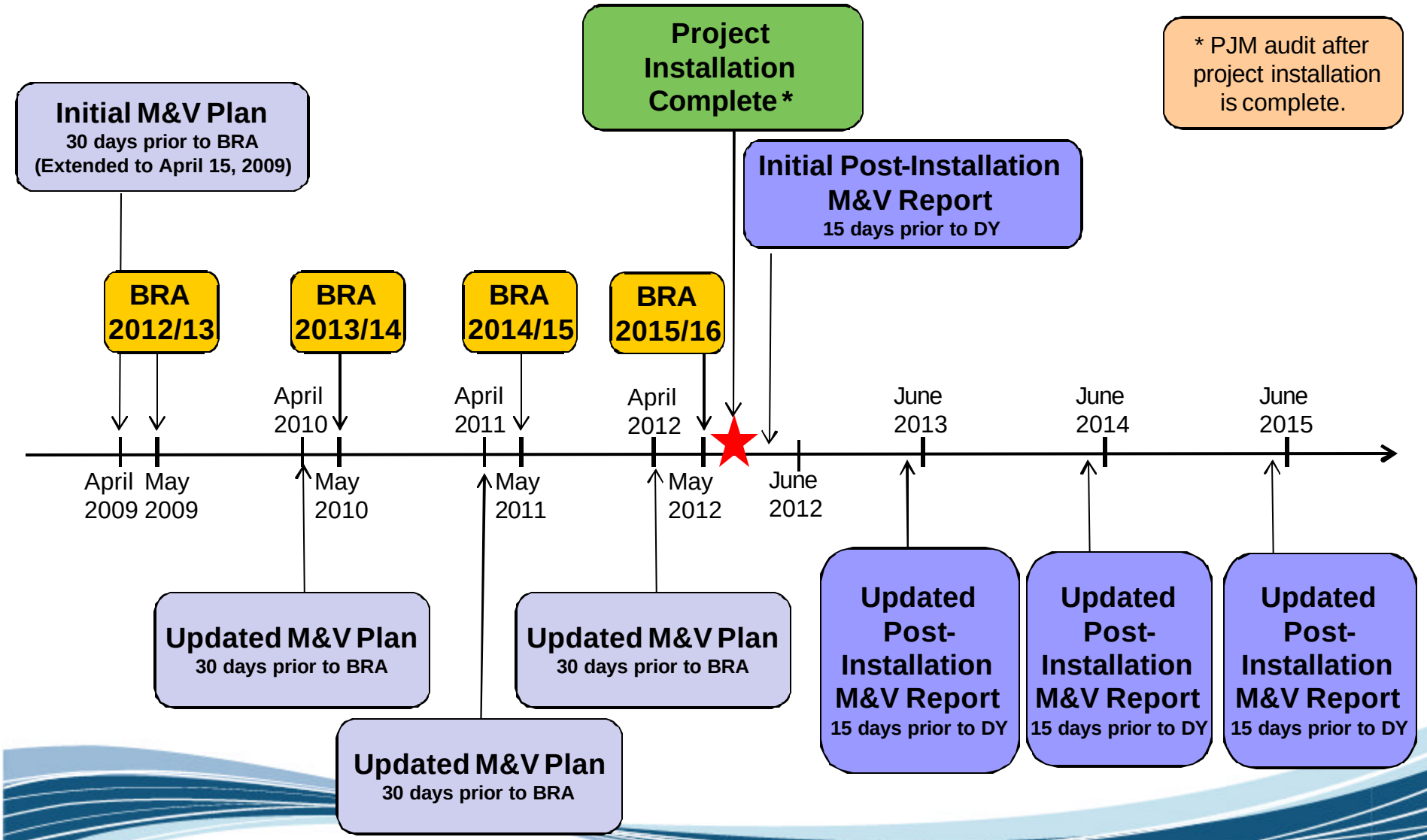
- Market Price for DR is the clearing price from the auction in which the DR cleared
- Market Price for ILR is the Final Zonal ILR Price for the Zone for the Delivery Year

Prior PJM Emergency Event

Demand Side Response Scheduled Curtailments
August 8, 2007



M&V Documentation Submittal Timeline



E-mail M&V documentation submittals to rpm_hotline@pjm.com.