July 7, 2014

PJM ERPIV Proposal:
Reserve Pricing

Real-Time 30-minute Reserve Market	Changes to Existing DASR Market
Integrated with Shortage Pricing methodology RTO-level.	Adjust requirement based on additionally scheduled capacity
Cleared only when PJM schedules additional generation beyond a threshold	Clear only up to economic max
Cleared only up to economic max	
Resource capability based on capacity that can be converted to energy in 30-minutes	
Allow for sub-zones to be created *NEW!*	
Real-time eligibility criteria *NEW!*	
Requirement based on additionally scheduled capacity *NEW!*	
30-minute Pre-Emergency Annual and Extended summer are eligible as appropriate *NEW!*	
Cost allocation to real-time load ratio share (consistent with DASR) *NEW!*	
Partial balancing settlement with DASR *NEW!*	

- PJM originally stated that the proposed 30-minute OR market would be RTO-based

- While this will still be the default configuration, PJM believes that it is necessary to allow for sub-zones to be created as needed
  - This is currently done for the Synchronized Reserve and Non-Synchronized Reserve Markets
    - RTO and MAD

- It is likely that MAD will be the sub-zone used if one is needed

- As with DASR, PJM proposes that there be eligibility criteria for RTOR
  - For DASR
    - Resources cannot shrink the range between their ecomax and ecomin from DA to RT
      - Forfeiture of DASR revenues
    - A resource with a 30 minute lead time that was compensated for DASR in the DAM forfeits all DASR credits for the entire day if it cannot start within 30 minutes when requested by PJM

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- An online, dispatchable, resource must be considered to be "following PJM dispatch" in order to receive RTOR credits
  - This is the same determination used to make resources whole

- The resource cannot have its economic min = economic max

- Possibly more to come…

Unit	Eco Min	Eco Max	Ramp Rate (MW / Min)	30 min ramping capability	Additional Reserves Created (Eco Min + ramping capability)
A	500	1000	10	300	800
B	200	300	1	30	230
C	500	800	5	150	650
D	300	400	5	100 (limited by eco max)	400
Total	**1500**	**2500**			**2080**

Trigger:

Hot Weather Alert, Cold Weather Alert, Max Emerg Gen Alert, Weather / Environmental Emergency, Sabotage / Terrorism Emergency

AND/OR

We've scheduled at least an additional .5% of forecasted peak load outside of the DA/RAC run based on the eco mins of the scheduled units

Example:

- Peak Load Forecast = 160,000

- DASR Requirement = 6.27% of peak load forecast = 10,032 MW

- Threshold for triggering reserve req = .5% * 160,000 = 800 MW

- Amount additionally scheduled = 1,500 MW

- Trigger RT OR requirement? *YES*

DASR Requirement Increase:

- 6.27% of 160,000 MW peak = 10,032 MW
- Sum of (eco min + DA Default RR*30) of units scheduled outside DA market and RAC run
  - 2,080 MW

Updated DASR Requirement = 6.27% of peak load plus above sum = 12,112 MW

Real Time Operating Reserve Requirement:

– Based on sum of (min (eco min + energy segmented ramp rate *30, eco max)) of units scheduled outside DA market and RAC run
  - ? + 2,080 MW
  - could be different from amount added to DASR requirement if additional units scheduled after DA market deadline
  - Also different if energy segmented ramp rate <> DA default ramp rate

– Need to determine if default DASR requirement, primary reserve requirement, or some other value is added to this number.
  - If added to DASR Requirement: 10,032 MW + 2,080 MW = 12,112 MW
  - If added to Primary Requirement: 2,063 MW + 2,080 MW = 4,143 MW

- DASR scheduled includes capacity to meet
    - Average forced outage rates
    - Average load forecast error
    - 10-minute reserve capability

- 10,032 MW of DASR scheduled based average errors
  - 3,376 MW for the 2.11% of LFE
  - 6,656 MW for the 4.16% eFOR
  6.27%
- Between LFE and eFOR there are 8,032 MW of "error"
- This leaves 2,000 MW of excess DASR scheduled on the system

  - How can we incorporate this into the RTOR Market?
    - Not accounting for it could suppress prices.
    - Over-accounting could unnecessarily escalate prices.

- Offline non-emergency resources able to start and provide energy within 30 minutes

- Online non-emergency generation resources or demand resources able to curtail within 30 minutes or increase their output within 30 minutes
    - Includes
        - Extended Summer, Pre-Emergency, 30-minute DR (during compliance period)
        - Annual, Pre-Emergency, 30-minute DR (all year)

- Other eligibility rules follow that of DASR *(Section 11, Manual 11)*

- PJM is proposing to have the costs of the RTOR market allocated to real-time load ration share

- This is consistent with the DASR Market

(Section 11, Manual 11)

- Settlement for DASR will be a partial balancing settlement
  - Resources providing real-time 30-minute reserves in excess of their DASR commitment for that hour will receive the RTORMCP
  - Resources providing less RTOR than their assigned DASR will not be required to buy back their shortfall

- The buy back portion of the balancing settlement potentially creates an incentive to maintain the committed DASR and not follow real-time dispatch

UNIT A	
Eco Min	100 MW
Eco Max	200 MW
Offer	$70/MWh
Ramp Rate	1 MW/min
OR Capability	30 MW

Unit is marginal in Day Ahead for DASR and is setting the clearing price.

UNIT A – DA Settlement	
DA LMP	$100/MWh
DA MW	180 MW
DASR MCP	$20/MWh
DASR MW	20 MW
DA LMP CREDITS	($100 * 180) = $18,000
DASR CREDITS	($20 * 20) = $400
DA OFFER COST	($70 * 180) = $12,600
DA SETTLEMENT	($18,000 + $400) - $12,600 = $5,800

UNIT A	
Eco Min	100 MW
Eco Max	200 MW
Offer	$70/MWh
Ramp Rate	1 MW/min
OR Capability	30 MW

Unit is marginal in real-time and preserves is Day Ahead margin.

UNIT A – Balancing Settlement	
RT LMP	$150/MWh
RT MW	170 MW
RTOR MCP	$80/MWh
RTOR MW	30 MW
BAL LMP CREDITS	(170 - 180) * $150 = -$1,500
RTOR CREDITS	(30 - 20) * $80 = $800
RT COST SAVINGS	(180 – 170) * $70 = $700
BAL SETTLEMENT	-$1500 + $700 + $800 = $0

UNIT A	
Eco Min	100 MW
Eco Max	200 MW
Offer	$70/MWh
Ramp Rate	1 MW/min
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Unit is marginal in Day Ahead for DASR and is setting the clearing price.

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UNIT A	
Eco Min	100 MW
Eco Max	200 MW
Offer	$70/MWh
Ramp Rate	1 MW/min
OR Capability	30 MW

RESOURCE WOULD HAVE BEEN FINANICALLY BETTER OFF NOT FOLLOWING DISPATCH AND MAINTAINING ITS DASR COMMITMENT.

UNIT A – Balancing Settlement	
RT LMP	$150/MWh
RT MW	200 MW
RTOR MCP	$100/MWh
RTOR MW	0 MW
BAL LMP CREDITS	(200 - 180) * $150 = $3000
RTOR CREDITS	(0 - 20) * $100 = -$2000
RT EXCESS COST	(200 – 180) * $70 = -$1400
BAL SETTLEMENT	$3000 - $2000 - $1400 = -$400

- Any time a resource with a DASR commitment would lose more in real-time by having to buy out of that commitment than the additional money it would make providing energy it has the incentive to not follow dispatch

- This will happen when:

  - RTORMCP > RT LMP – MARGINAL COST

- In order preserve the incentive to follow dispatch at all times, PJM proposes that resource not have to buy out of their DASR commitment if they are dispatched for energy in RT
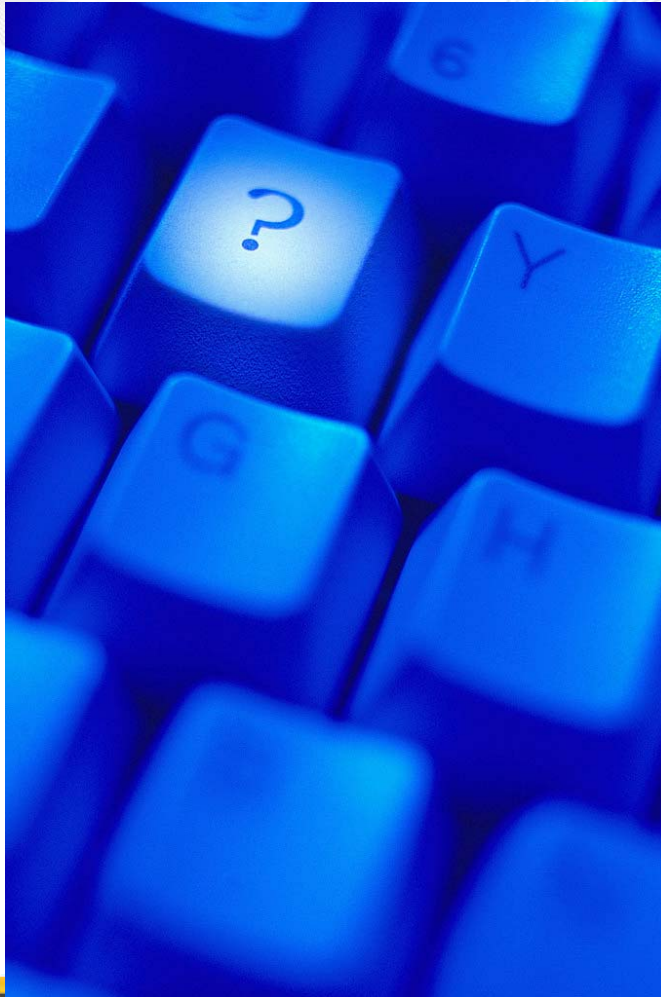
June 25, 2014

PJM ERPIV Proposal:
Reserve Pricing

- Implementation of real-time 30-minute Operating Reserve (RT OR) Market with Operating Reserve Demand Curve

- Tweaks to the existing DASR market to incorporate known additionally scheduled resources

ment

- Current DASR requirement is 6.27% of peak load
  - 2.11% average load forecast error
  - 4.16% average forced outage rate
- A portion of these reserves is used to meet the existing Primary and Synchronized reserves needs during the operating day
- PJM's proposal is to price resources scheduled in excess of these requirements to articulate the need for such resources and reduce uplift
- Scheduling additional resources typically only occurs during emergency conditions

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- Real-time market only cleared on when capacity scheduled beyond typical reserve requirements in Section 2.3.2 of M-13 (existing 6.27%)
  - On all other days the requirement will be zero
  - Likely only occurs during emergency conditions
    - HWA
    - CWA
    - Maximum Generation Alert
    - Weather/Environmental Emergency (i.e., Hurricane Sandy)
    - Sabotage/Terrorism Emergency

1. HWA, CWA, Max Gen Alert, Weather/Environmental/Sabotage/Terrorism Emergency

AND/OR

2. PJM schedules an additional 0.5% capacity beyond the default DASR requirement based on peak load forecast
   - 0.5% of 160,000 MW is about 800 MW
   - Based on the sum of the economic mins of the additional resources scheduled
     - Generators scheduled for reserve and anticipated to run at min
     - These resources offset economically scheduled generation by that amount
     - Once dispatched from min they are no longer extra capacity

- RTO-wide
  - no locational component

- Requirement
  - Calculated once for the on and off peak period of the day
    - 2300 the day prior for the off-peak (0000-0459)
    - 0400 the day of for the on-peak (0500-2359)
  - Based on the additional resources scheduled
    - $\sum$ (Economic min + 30 minute reserve capability)
    - Need to consider incorporation of existing DASR requirement

- RT OR requirement would be nested with existing Primary and Synchronized Requirements
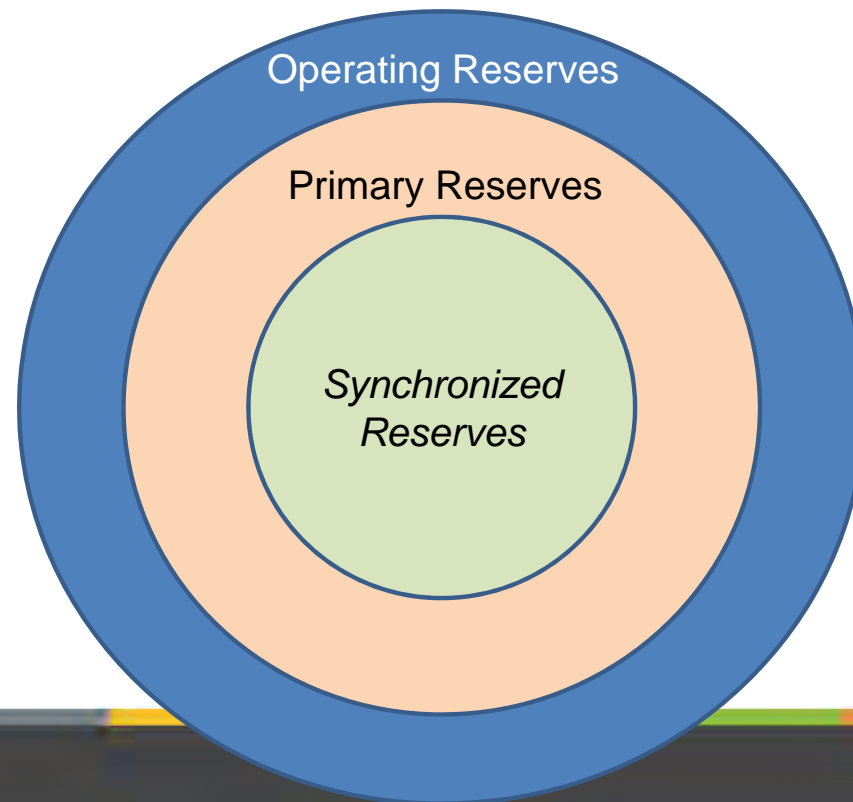
- Requirements (example only)
    - 5,000 MW Operating Reserve (30 minute on/offline)
    - 2,000 MW Primary Reserves (10 minute on/offline)
    - 1,300 MW Synch Reserves (10 minute online)

- 5,000 MWs of total 30 minute reserve capability of which
    - 2,000 MW can be loaded within 10 minutes
    - 1,300 MW is synchronized and can be loaded within 10 minutes

- Requirements are nested, not additive

- Availability based on energy availability
  - All resources available for energy that have 30 minute reserve capability
- All offers are $0
  - Clearing based on joint optimization of energy and reserves and determined by the marginal resource's opportunity cost
- Shortage pricing demand curve
  - Single step curve
    - Consistent with existing curve shapes for PR/SR
    - Analysis will be based on DASR prices observed during peak periods

- **Eligible capacity**
  - Same eligibility rules as DASR (Section 11 of M-11)
  - Further discussion required for Pre Emergency DSR inclusion

- **Resource capability**
  - *Online resources*: Lesser of (Eco Max – Dispatch point) and (Segmented energy ramp rate * 30 minutes)
    - Similar to SR capability
  - *Offline resources*: Lesser of Eco Max and [Eco Min + (30 minutes – (startup time + notification time)) * Segmented energy ramp rate]
    - Similar to NSR capability

- Increase requirement by known amount of additionally scheduled capacity using the same trigger point
  - Increase would be based on the (economic min + 30 minute reserve capability) of such resources
- Change 30 minute reserve capability to be capped at economic max instead of the current emergency max
  - Current DASR requirement is based on average forced outage rate and average load forecast error
  - Using emergency capacity as part of the resource's capability assumes that when we see average load forecast error and average forced outage, we will deploy emergency capacity. **This is inconsistent with how PJM operates.**

- How settlement with existing DASR mechanism will work
  - Balancing settlement only?
- Use of Pre Emergency demand response
- Demand curve penalty factor
- Finalizing the RT OR requirement
- Non-performance penalties
- Cost allocation
  - Load?
  - Deviations?
  - Something else?