



# Quadrennial Review of VRR Curve Parameters: PJM Preliminary Recommendations related to Net E&AS Offset Determination

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- Maintain Peak-Hour Dispatch methodology for determination of Net EAS revenues for reference resource CT with following updates:
  - Update Reference Resource characteristics and costs
  - Include a 10% cost adder in dispatch cost
  - Update natural gas pricing hubs for 6 zones
- Determine annual Net EAS revenue of reference resource as the sum of the median monthly values of each month of prior three year calendar period versus current use of sum of the average monthly values
- Determine Net CONE of multi-zone LDAs as the median zonal Net CONE calculated for the zones in the LDA versus current use of average zonal Net CONE
- Determine the RTO Net CONE using the median zonal Net EAS calculated for all PJM zones versus current use of peak-hour dispatch of reference resource CT using PJM RTO LMPs and blend of RTO-wide gas price indices

- The Peak-Hour Dispatch Method used to estimate Net EAS revenues for the reference CT and CC was validated by comparison to the actual Net EAS revenues of representative units (Brattle Report section II.B.)
  - Comparison was limited to CCs due to lack of representative CTs
- The Peak-Hour Dispatch method was found to provide estimates that are reasonably consistent with the representative units' actual net energy revenues
- Estimated values fall within the range of the representative units' actual net energy revenues with results found to vary by region and with estimated values tending to be slightly higher than actual net energy revenues on average
- PJM recommends maintaining the Peak-Hour Dispatch method as currently defined to estimate the Net EAS offset of the Reference CT with the updates listed on following slides

- Update unit characteristics to reflect the GE Frame Model 7HA.02 CT

Unit Characteristics	Current (GE 7FA - 2X)	Update (GE 7HA - 1X)
Capacity	380 MW (190 MW x 2)	320 MW
Heat Rate (Btu/kWh)	10,096	9,134
Variable O&M (\$/MWh)	\$6.47	\$7.00

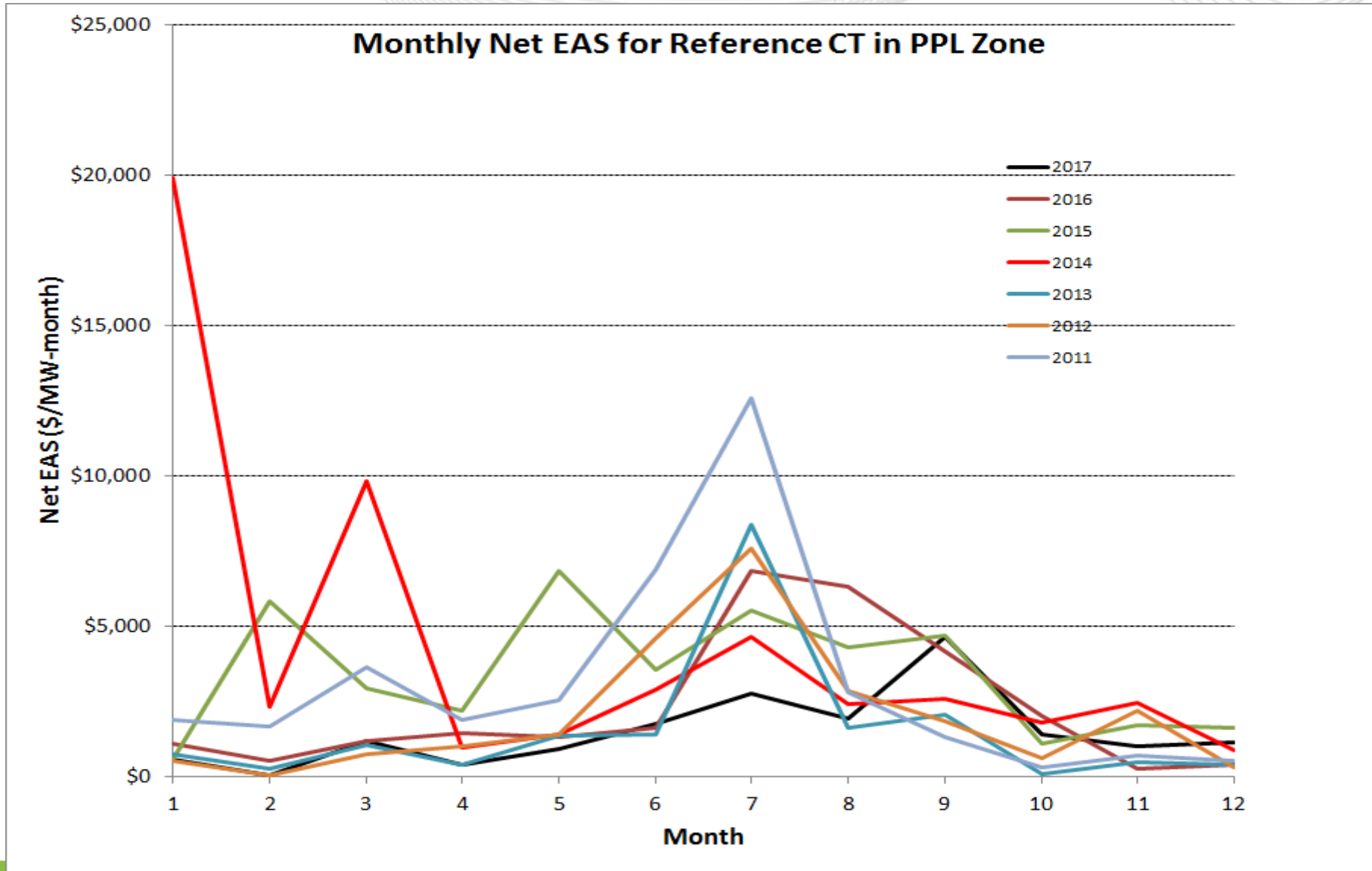
- Include a 10% cost adder in the dispatch cost offer of the reference resource
  - 10% adder is not included in current peak-hour dispatch model contributing to observed higher estimated net energy revenues relative to actual representative units

- Update natural gas pricing hubs for the 6 zones indicated below

<b>Zone</b>	<b>Current Hub</b>	<b>Recommended Hub</b>
APS	Columbia-APP/TCO Pool	Dominion-South
DUQ	Columbia-APP/TCO Pool	Dominion-South
PENELEC	Dominion-North	Transco-Leidy Line
PEPCO	Transco-Z6 (non-NY)	Transco-Z5 Div
PPL	TETCO M3	Transco-Leidy Line
PSEG	Transco-Z6 (NY)	Blend Z6 (NY/non-NY)

- See Appendix section for zonal mapping of gas price hubs for all zones

- Currently, the expected annual Net EAS of the reference resource is determined as the average annual Net EAS of the three most recent calendar years
  - Equivalent to the sum of the average monthly Net EAS values determined for each month over the three prior calendar year periods
- Use of the average monthly Net EAS values yields an annual Net EAS value that can be disproportionately affected by the Net EAS of a single month having a value that is significantly lower or higher than other values for that month; whereas, use of the median monthly Net EAS mitigates this affect
  - Absent extreme high or low values, the average and median will tend to converge
- PJM recommends use of the median monthly Net EAS value as opposed to the average monthly Net EAS value in order to provide an annual Net EAS estimate that better represents an expected annual Net EAS under normal conditions





# 3-year Monthly Median versus 3-year Monthly Average (cont.)

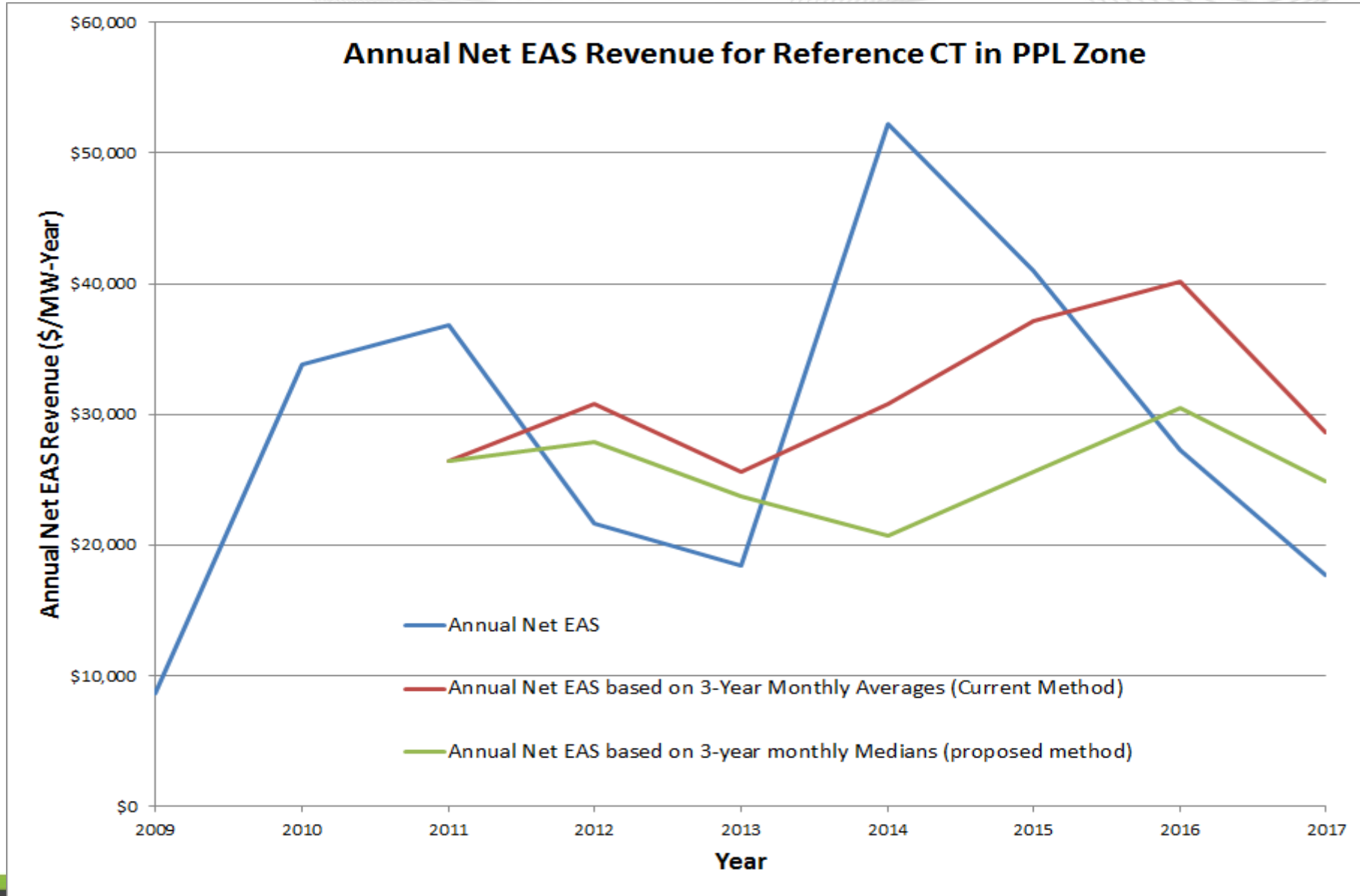
Month	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>	2017/2018 BRA 2011, 2012, 2013		2018/2019 BRA 2012, 2013, 2014	
					Average	Median	Average	Median
1	\$1,886	\$1,118	\$745	\$19,929	\$1,250	\$1,118	\$7,264	\$1,118
2	\$1,676	\$36	\$276	\$2,340	\$663	\$276	\$884	\$276
3	\$3,641	\$732	\$1,065	\$9,829	\$1,813	\$1,065	\$3,875	\$1,065
4	\$1,871	\$961	\$414	\$969	\$1,082	\$961	\$781	\$961
5	\$2,529	\$1,541	\$1,375	\$1,398	\$1,815	\$1,541	\$1,438	\$1,398
6	\$6,886	\$4,549	\$1,413	\$2,910	\$4,283	\$4,549	\$2,957	\$2,910
7	\$12,607	\$5,864	\$8,365	\$4,672	\$8,945	\$8,365	\$6,300	\$5,864
8	\$2,827	\$2,781	\$1,648	\$2,414	\$2,418	\$2,781	\$2,281	\$2,414
9	\$1,312	\$1,618	\$2,074	\$2,606	\$1,668	\$1,618	\$2,099	\$2,074
10	\$322	\$555	\$101	\$1,803	\$326	\$322	\$819	\$555
11	\$716	\$1,664	\$506	\$2,476	\$962	\$716	\$1,549	\$1,664
12	\$523	\$216	\$421	\$870	\$387	\$421	\$503	\$421
	<b>\$36,797</b>	<b>\$21,633</b>	<b>\$18,403</b>	<b>\$52,214</b>	<b>\$25,611</b>	<b>\$23,734</b>	<b>\$30,750</b>	<b>\$20,720</b>





# 3-year Monthly Median versus 3-year Monthly Average (cont.)

Month	2014	2015	2016	2017	2020/2021 BRA 2014, 2015, 2016		2021/2022 BRA 2015, 2016, 2017	
					Average	Median	Average	Median
1	\$19,929	\$5,841	\$1,107	\$554	\$8,959	\$5,841	\$2,501	\$1,107
2	\$2,340	\$2,945	\$515	\$28	\$1,933	\$2,340	\$1,163	\$515
3	\$9,829	\$2,195	\$1,182	\$1,192	\$4,402	\$2,195	\$1,523	\$1,192
4	\$969	\$6,834	\$1,432	\$383	\$3,078	\$1,432	\$2,883	\$1,432
5	\$1,398	\$3,557	\$1,311	\$928	\$2,089	\$1,398	\$1,932	\$1,311
6	\$2,910	\$5,524	\$1,639	\$1,747	\$3,358	\$2,910	\$2,970	\$1,747
7	\$4,672	\$4,285	\$6,826	\$2,752	\$5,261	\$4,672	\$4,621	\$4,285
8	\$2,414	\$4,697	\$6,331	\$1,918	\$4,480	\$4,697	\$4,315	\$4,697
9	\$2,606	\$1,109	\$4,189	\$4,661	\$2,635	\$2,606	\$3,320	\$4,189
10	\$1,803	\$1,728	\$2,035	\$1,422	\$1,855	\$1,803	\$1,728	\$1,728
11	\$2,476	\$1,639	\$288	\$1,002	\$1,468	\$1,639	\$976	\$1,002
12	\$870	\$1,107	\$403	\$1,145	\$793	\$870	\$885	\$1,107
	<b>\$52,214</b>	<b>\$41,461</b>	<b>\$27,259</b>	<b>\$17,732</b>	<b>\$40,311</b>	<b>\$32,401</b>	<b>\$28,817</b>	<b>\$24,311</b>



- Current method determines the Net CONE of a multi-zone LDA as the average of the Net CONE values determined for each zone in the LDA
- Use of the average of the zonal Net CONE values yields an LDA Net CONE value that can be disproportionately affected by the Net CONE of a single zone having a value that is significantly lower or higher than the other zonal values; whereas, use of the median zonal Net CONE mitigates this affect
- PJM recommends change to use the median versus the average in order to provide a Net CONE that better represents the entire LDA
- There are currently three multi-zone LDAs (EMAAC, MAAC & SWMAAC)
  - SWMAAC LDA is unaffected by this change as it contains only 2 zones
- The impact of this proposed change on the MAAC and EMAAC Net CONE values of the past four BRAs is shown on next two slides



# Net CONE of Multi-Zone LDAs (cont.) MAAC LDA Example

	2021/2022	2020/2021	2019/2020	2018/2019
Zone/LDA	Net CONE (\$/MW-Day)	Net CONE (\$/MW-Day)	Net CONE (\$/MW-Day)	Net CONE (\$/MW-Day)
<b>AE</b>	<b>\$330.01</b>	\$300.11	\$299.55	\$291.86
<b>DPL</b>	\$300.18	\$254.97	\$262.27	\$258.32
<b>JCPL</b>	\$294.26	\$261.99	\$262.34	\$277.58
<b>PE</b>	\$299.79	\$272.39	\$277.69	\$287.96
<b>PSEG</b>	\$330.61	<b>\$306.92</b>	<b>\$303.30</b>	<b>\$297.99</b>
<b>RECO</b>	\$327.76	\$302.22	\$296.64	\$295.20
<b>BGE</b>	\$244.33	\$178.33	\$215.62	\$235.59
<b>PEPCO</b>	\$285.42	\$226.53	\$244.23	\$250.74
<b>METED</b>	\$292.02	\$265.98	\$278.46	\$283.25
<b>PENELEC</b>	<b>\$214.45</b>	<b>\$139.60</b>	<b>\$164.43</b>	<b>\$225.05</b>
<b>PPL</b>	\$300.72	\$267.33	\$277.74	\$284.79
<b>MAAC</b>	<b>Average</b>	<b>\$292.69</b>	<b>\$252.40</b>	<b>\$271.67</b>
	<b>Median</b>	<b>\$299.79</b>	<b>\$265.98</b>	<b>\$277.69</b>
<b>Delta</b>	\$7.10	\$13.58	\$15.67	\$11.58
<b>% Delta</b>	2.4%	5.4%	6.0%	4.3%

Range	\$116.16	\$167.32	\$138.87	\$72.94
Std Dev	\$35.70	\$52.46	\$41.31	\$25.20
Skewness	-1.19	-1.23	-1.49	-0.85

**Minimum Zonal Net Cone / Maximum Zonal Net CONE**

The Net CONE of the Penelec Zone has been significantly lower than of the other zones in the LDA disproportionately impacting the average Net CONE.

Use of the median zonal Net CONE mitigates the impact of a single zone having a Net CONE that differs significantly from the other zones providing an LDA Net CONE that better represents the Net CONE associated with the entire LDA.



# Net CONE of Multi-Zone LDAs (cont.) EMAAC LDA Example

	2021/2022	2020/2021	2019/2020	2018/2019	
Zone/LDA	Net CONE (\$/MW-Day)	Net CONE (\$/MW-Day)	Net CONE (\$/MW-Day)	Net CONE (\$/MW-Day)	
AE	\$330.01	\$300.11	\$299.55	\$291.86	
DPL	\$300.18	\$254.97	\$262.27	\$258.32	
JCPL	\$294.26	\$261.99	\$262.34	\$277.58	
PE	\$299.79	\$272.39	\$277.69	\$287.96	
PSEG	\$330.61	\$306.92	\$303.30	\$297.99	
RECO	\$327.76	\$302.22	\$296.64	\$295.20	
EMAAC	Average	\$313.77	\$283.10	\$283.63	\$284.82
	Median	\$313.97	\$286.25	\$287.17	\$289.91
	Delta	\$0.20	\$3.15	\$3.53	\$5.09
	% Delta	0.1%	1.1%	1.2%	1.8%

Range	\$36.35	\$51.95	\$41.03	\$39.67
Std Dev	\$17.34	\$22.69	\$18.73	\$14.80
Skewness	-0.19	-0.19	-0.26	-1.41

Minimum Zonal Net Cone / Maximum Zonal Net CONE

For the EMAAC LDA, the zonal Net CONE values are more tightly grouped than those of MAAC therefore the median zonal Net CONE does not differ significantly from the average zonal Net CONE.

Absent extreme low or high values, the median and average will converge

The median zonal Net CONE will provide an LDA Net CONE that better represents the entire LDA in the case where the Net CONE of a single zone deviates significantly from the other zones

- The RTO Net CONE is currently calculated as the average gross CONE (of the 4 CONE Regions) minus a Net EAS offset that is determined by a Peak-Hour Dispatch of the reference resource against the hourly RTO LMP at a fuel price based on a blend of gas pricing points throughout the RTO resulting in:
  - Electricity and gas prices that are likely not consistent with one another, and
  - Electricity prices against which no actual resource would be dispatched using fuel price point that no actual resource would see
- PJM recommends change to instead determine the RTO Net EAS offset as the median zonal Net EAS calculated for all PJM zones

# Appendix



## Recommended Updates to Gas Pricing Point assigned to PJM Zones

<b>Zone</b>	<b>Current Fuel Index Points</b>	<b>Recommended Updates</b>
COMED	Chicago Citygates	
AEP	Columbia-APP	
APS	Columbia-APP	Dominion-SOUTH
ATSI	Columbia-APP	
DAYTON	Columbia-APP	
DEOK	Columbia-APP	
DLCO	Columbia-APP	Dominion-SOUTH
EKPC	Columbia-APP	
PENELEC	Dominion-NORTH	Transco-Leidy
JCPL	TETCO M3	
METED	TETCO M3	
PE	TETCO M3	
PPL	TETCO M3	Transco-Leidy
DOM	Transco-Z5 (non-WGL)	
AE	Transco-Z6 (non-NY)	
BGE	Transco-Z6 (non-NY)	
DPL	Transco-Z6 (non-NY)	
PEPCO	Transco-Z6 (non-NY)	Transco Z5 Delivered
PSEG	Transco-Z6 (non-NY)	Transco-Z6 (NY/non-NY blend)
RECO	Transco-Z6 (non-NY)	