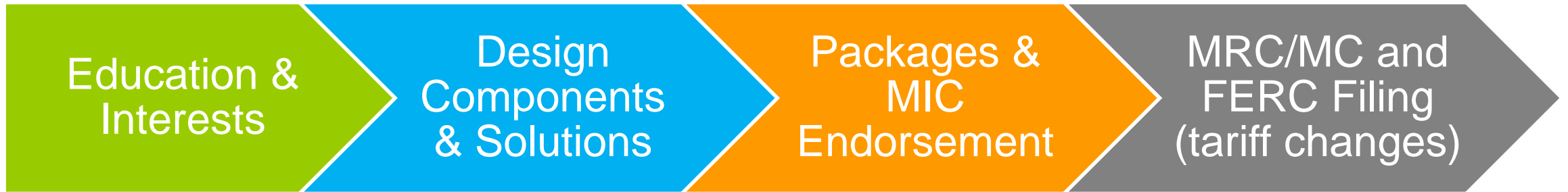


Balancing Ratio Determination

Patrick Bruno
Sr. Engineer, Capacity Market Operations
Markets Implementation Committee
March 7, 2018

- The current rules set the default Market Seller Offer Cap (“MSOC”) for Capacity Performance (“CP”) Resources equal to Net CONE times the average historical Balancing Ratios experienced during Performance Assessment *Intervals* in the three calendar years that immediately precede the Base Residual Auction (“BRA”) for the Delivery Year
 - Average historical Balancing Ratio becomes indeterminable when no Performance Assessment Intervals have occurred during the prior three calendar years
 - If determinable, may not be in time to inform the unit-specific MSOC submission deadline 120 days prior to the BRA (mid-January)
- The CP Non-Performance Charge Rate currently uses an assumed 30 Performance Assessment Hours for the Delivery Year
 - 30 hour assumption should be reviewed; No emergency actions triggering Performance Assessments Hours/Intervals have occurred since CP implementation

1. Provide education on the calculation of the MSOC and Balancing Ratio
2. Provide education on the determination of Non-Performance Charge Rates
3. Develop and discuss alternative Balancing Ratio calculation methodologies for use in the determination of the default MSOC
4. Develop and discuss alternative methods to determine the Non-Performance Charge Rate



Feb-Mar MIC	Mar-May MIC	Jun-Jul MIC	Jul-Aug MRC (Sept MC)
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★ File endorsed changes with FERC by early October 2018

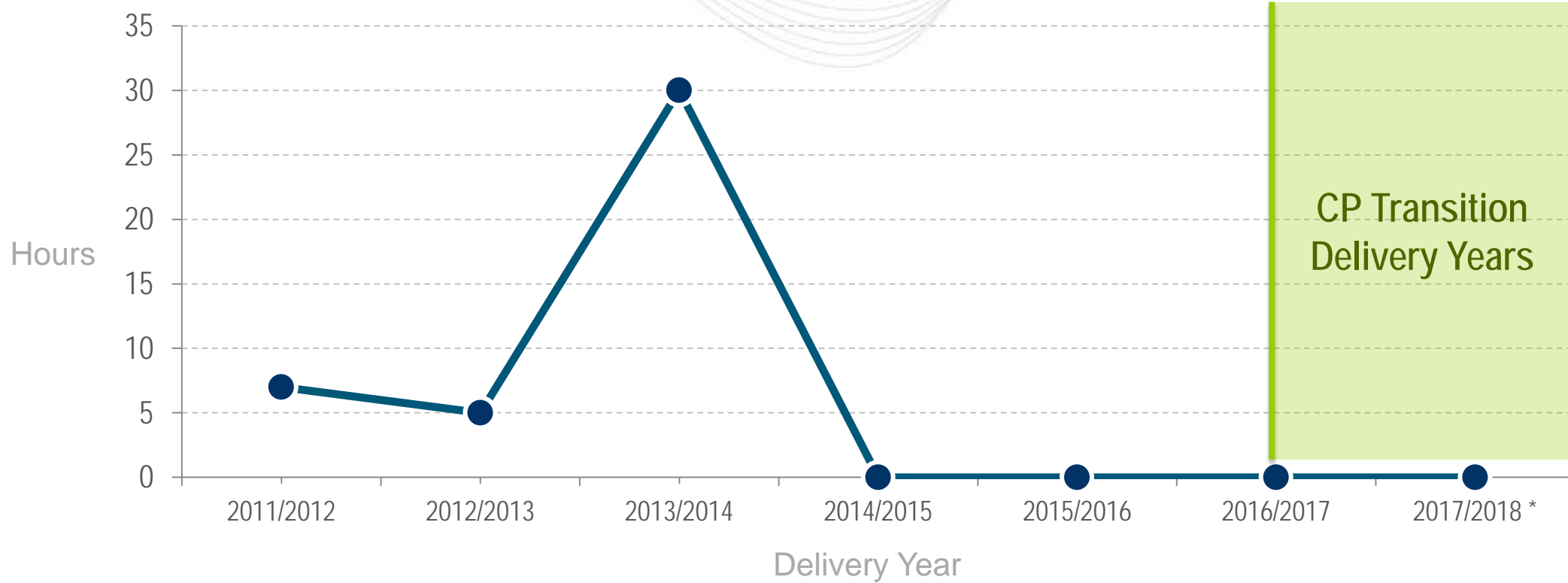
Appendix - Prior Education

CP default MSOC = **Net CONE x Balancing Ratio (B')**

Where:

- Net CONE is the Net Cost of New Entry (stated in \$/MW-Day, ICAP terms) for the relevant Delivery Year and zone in which the resource is located
- Balancing Ratio (B') is the historical average of the Balancing Ratios experienced during Performance Assessment Intervals/Hours in the three most recent calendar years preceding the Base Residual Auction for such Delivery Year
 - Represents the expected Balancing Ratio across all Performance Assessment Intervals/Hours for a Delivery Year
- CP default MSOC is expressed in \$/MW-Day

Historical RTO Performance Assessment Hours



Note: Hours shown prior to 2016/2017 reflect Emergency Actions that would have triggered a Performance Assessment Hour under the CP rules

- Average Balancing Ratios calculated for use in the default MSOC by Delivery Year

Delivery Year	MSOC Balancing Ratio
2018/2019	85.0%
2019/2020	81.0%
2020/2021	78.5%
2021/2022	78.5% *

** 2021/2022 Balancing Ratio in the MSOC set to the same value as prior Delivery Year due to absence of Performance Assessment Hours in prior three calendar years (2015 - 2017), as approved by FERC*

- A list of the underlying Performance Assessment Hours and corresponding Balancing Ratios used to determine the above averages are included in Appendix 2 of PJM’s response to FERC on April 10, 2015 in Docket No. ER15-623-001

- The calculated Balancing Ratio for a Performance Assessment Interval represents the percentage share of total generation capacity commitments needed to support the load and reserves on the system within the Emergency Action Area during the interval
 - i.e. (Load + Reserves) / Generation Capacity Commitments
- The Balancing Ratio is used to set the Expected Performance level of Generation Capacity Performance Resources within the Emergency Action Area during the Performance Assessment Interval
 - Expected Performance = Capacity Commitment (UCAP) x Balancing Ratio

Total Actual Generation and Storage Performance + Net Energy Imports * + Demand Response Bonus Performance

All Generation and Storage Committed UCAP

$$\text{Non-Perf. Charge Rate}^* = \text{Net CONE} \times 365 \text{ days} / 30 \text{ hours}$$

Where:

- Net CONE is the Net Cost of New Entry (stated in \$/MW-Day, ICAP terms) for the relevant Delivery Year and LDA in which the resource is modeled
- 30 hours is the estimated number of Performance Assessment Hours that may occur in a Delivery Year
 - Based on Emergency Action hours seen during 2013/2014
- Non-Performance Charge Rate is expressed in \$/MWh to be multiplied by a unit's Performance Shortfall to calculate the assessed penalty charges

* Charge Rate does not reflect the filed change with 5-minute Settlements, which further divides the rate by the number of Real-Time Settlement Intervals in an hour



Non-Performance Charge Rates

LDA	18/19 Non-Performance Charge Rate (\$/MWh)	19/20 Non-Performance Charge Rate (\$/MWh)	20/21 Non-Performance Charge Rate (\$/MWh)
RTO	\$3,424.80	\$3,401.17	\$3,329.31
MAAC	\$3,095.44	\$2,977.55	\$2,868.54
EMAAC	\$3,245.22	\$3,223.07	\$3,217.35
SWMAAC	\$2,770.72	\$2,612.79	\$2,300.60
PSEG	\$3,395.35	\$3,446.56	\$3,488.06
PS-NORTH	\$3,395.35	\$3,446.56	\$3,488.06
DPL-SOUTH	\$2,943.36	\$2,980.31	\$2,897.73
PEPCO	\$2,856.98	\$2,775.37	\$2,574.50
ATSI	\$3,096.05	\$3,000.64	\$2,968.21
ATSI-CLEVELAND	\$3,096.05	\$3,000.64	\$2,968.21
COMED	\$3,649.39	\$3,732.33	\$3,748.21
BGE	\$2,684.33	\$2,450.29	\$2,026.74
PPL	\$3,244.97	\$3,156.12	\$3,038.16
DAYTON			\$3,104.21
DEOK			\$3,210.14

$$\text{Stop-Loss} = \text{Net CONE} \times 365 \text{ days} \times 1.5 \times \text{Committed MW}$$

Where:

- Net CONE is the Net Cost of New Entry (stated in \$/MW-Day, ICAP terms) for the relevant Delivery Year and modeled LDA in which the resource resides
- Committed MW is the resource's capacity commitment in UCAP
- Based on the maximum clearing price allowed by the VRR curve at Net CONE times 1.5
- At 30 assumed Performance Assessment Hours in the Non-Performance Charge Rate, a resource will hit the stop-loss after 45 hours of zero Actual Performance

CP Default MSOC Rationale

- The default MSOC reflects the amount that a competitive resource with low net going forward costs (Low ACR Resource) would accept in the capacity market
 - A Low ACR Resource is one whose net avoidable costs are less than its total expected Bonus Performance payments as an energy-only resource
 - Represents the lost opportunity costs incurred by taking on a capacity obligation and foregoing some expected Bonus Performance payments
- The Balancing Ratio (B') is a component of the default MSOC calculation to reflect the percentage share of expected Bonus Performance payments that are foregone by taking on a capacity obligation
 - A resource will receive Bonus Payments for its production that exceeds the Balancing Ratio share of its capacity obligation during Performance Assessment Intervals/Hours regardless of it having a capacity obligation

Note: A resource with high net going forward costs that exceed expected Bonus Performance payments can go through the resource-specific MSOC process for a higher CP offer cap

	Capacity Resource	Energy-Only
Nameplate (MW)	100	100
Capacity Obligation (UCAP MW)	100	0
Net CONE (\$/MW-day)	\$250	\$250
Balancing Ratio (B')	0.9	0.9
Actual Performance (A')	100	100
Expected Performance (MW)	90	-
Bonus Performance (MW)	10	100
Bonus Rate (\$/MWh)	\$3,042	\$3,042
Bonus Performance Hours	30	30
Annual Bonus Performance (\$/year)	\$912,500	\$9,125,000
Foregone Bonus Performance (\$/year)	\$8,212,500	-
Lost Opportunity Cost (\$/MW-day)	\$225	-
Default MSOC of Net CONE x B' (\$/MW-day)	\$225	-

$$p = PPR \times H \times B' + \max\{0, (ACR - PPR \times H \times A')\}$$

Where:

- p: Offer price in RPM on a UCAP basis (\$/MW-year)
- PPR: Non-Performance Charge Rate (\$/MWh)
 - Assumed to be equivalent to the Bonus Performance Rate
- H: Expected number of Performance Assessment Hours in the year (hours/year)
- B': Expected value of balancing ratio across all Performance Assessment Hours in year
- ACR: Net ACR (net going forward costs) for a resource (\$/MW-year)
- A': Expected value of availability across all Performance Assessment Hours in year

Note: The full overview and explanation of the Capacity Performance Offer Cap Logic can be found in Appendix 1 of PJM's April 10, 2015 response to FERC in Docket No. ER15-623-001

Low ACR Resource is one whose net avoidable costs are less than its total expected Bonus Performance payments as an energy-only resource

- Second term of competitive offer drops to zero
- PPR substituted with Non-Performance Charge Rate

$$P_{(\$ / \text{MW-year})} = \text{PPR} \times H \times B' + \max\{0, (\text{ACR} - \text{PPR} \times H \times A')\}$$

$$P_{(\$ / \text{MW-year})} = (\text{Net CONE} \times 365 / H) \times H \times B'$$

$$P_{(\$ / \text{MW-year})} = \text{Net CONE} \times 365 \times B'$$

$$P_{(\$ / \text{MW-day})} = \text{Net CONE} \times B' \longrightarrow \text{CP default MSOC}$$

High ACR Resource is one whose net avoidable costs are greater than its total expected Bonus Performance payments as an energy-only resource

- Second term of competitive offer remains greater than zero
- PPR substituted with Non-Performance Charge Rate
- Competitive offer dependent on unit-specific ACR and expected resource performance compared to B', requiring a unit-specific review of its MSOC
 - An appropriate unit-specific risk premium may also be included in the unit-specific review

$$P_{(\$ / \text{MW-year})} = \text{PPR} \times H \times B' + (\text{ACR} - \text{PPR} \times H \times A')$$

$$P_{(\$ / \text{MW-year})} = \text{ACR} + \text{PPR} \times H \times (B' - A')$$

$$P_{(\$ / \text{MW-year})} = \text{ACR} + (\text{Net CONE} \times 365 / H) \times H \times (B' - A')$$

$$P_{(\$ / \text{MW-day})} = \text{ACR} + \text{Net CONE} \times (B' - A')$$