



Performance Assessment Interval Education

MIC Special Session
Sept. 23, 2020

The following slides are meant to provide transparency into the process PJM followed to assess the Oct. 2, 2019 PAI.

For simplicity, the rules regarding Base Capacity are omitted as they are no longer relevant starting June 1, 2020.

PJM recognizes that better transparency to certain areas of the process is needed. Those areas are noted throughout the slides.

- The purpose of a Performance Assessment is to evaluate the performance of committed capacity resources during emergency conditions.
- Resources with CP commitments that fail to perform are subject to Non-Performance Charges, and resources (capacity or energy-only) that over-perform may be eligible for Bonus Performance Credits.

- Performance Assessment Interval (PAI) shall mean each Real-time Settlement Interval for which an Emergency Action has been declared by PJM.
- Emergency Actions shall mean any emergency action for locational or system-wide capacity shortages that either utilizes pre-emergency mandatory load management reductions or other emergency capacity, or initiates a more severe action.
- Performance is assessed for each interval that PJM declares specific actions or warnings.
- Compare a resource's Expected Performance against Actual Performance for each Performance Assessment Interval.

Performance Assessment Interval (PAI) shall mean each Real-Time Settlement Interval for which an Emergency Action has been declared by PJM.

PAI Triggers:

**Steps 1–10 in Sections 2 and 5
of Emergency Procedures Manual 13**

- Pre-Emergency Load Management Reduction Action (30, 60 or 120 minutes)
- Emergency Load Management Reduction Action (30, 60 or 120 minutes)
- Primary Reserve Warning
- Maximum Generation Emergency Action
- Emergency Voluntary Energy-Only Demand Response Reduction Action
- Voltage Reduction Warning & Reduction of Critical Plant Load
- Curtailment of Non-Essential Building Load
- Deploy All Resources Action
- Manual Load Dump Warning
- Voltage Reduction Action
- Manual Load Dump Action

■ Warnings

■ Actions

**Section 5.7 of
Emergency Procedures Manual 13**

- Load Shed Directive

Hot Weather Alerts and
Cold Weather Alerts
ARE NOT triggers

- **OATT, Attachment DD, Section 10A (c):** “Such calculation shall encompass all resources and Price Responsive Demand located in the area defined by the Emergency Action.”
- **Manual 18, Section 8A:** “The Non-Performance Assessment will encompass all resources located in the area defined by the Emergency Action.”
 - Manual language does not address cases where a pre-defined area does not yet exist to control an operational issue that occurs in real time.



Identified by PJM as area that would benefit from greater *transparency*

- When Emergency Procedures are called for the RTO or a given Zone, the Performance Assessment will encompass all resources (capacity and energy-only resources) in the defined region.
 - Performance of Demand Resources is only evaluated if dispatched for 30 minutes or more of the clock hour.
 - Effective with the 2020/2021 Delivery Year, External Generation Capacity Resources are included in the assessment if such external resources would have helped resolve the declared Emergency Action.

- Depending on system conditions, PJM Dispatch may need to issue sub-zonal Emergency Procedures.
 - There isn't always a pre-defined area that meets the immediate system need.
- If the sub-zonal event is a result of a transmission-related emergency, PJM determines the list of units to be assessed based on their ability to help the constraint.
 - Generation located in the Zone where the event was called that would relieve the constraint if output was increased are included in the assessment.
 - Example: May 29, 2018 Load Shed Directive in AEP

Balancing Ratio

Balancing Ratio (BR) is used to calculate a Capacity Performance resource's Expected Performance value

*Total Actual Generation and Storage Performance
+ Net Energy Imports*
+ Demand Response Bonus Performance
+ PRD Bonus Performance (starting 2022/2023 DY)*



*All Generation and
Storage Committed
UCAP*

Unique Balancing Ratio is calculated for each Performance Assessment Interval declared by the Emergency Action

**Note: Net energy imports are included only when external resources are included in the PAI assessment*

- **The Actual Generation and Storage Performance** used in the determination of the Balancing Ratio is calculated as metered output + real-time ancillary service assignment.
- **The metered output** is the MW values provided through Power Meter and calculated according to the Revenue Data for Settlements methodology in Manual 28, Section 1A.
- **The real-time ancillary service assignment accounts for:** Regulation, Tier 2 Synchronized Reserves, or Non-Synchronized Reserves.
 - The adjustments made to the actual performance for these real-time ancillary services capture any movement off the economic basepoint of the resources to provide the service.
 - Tier 1 reserve *estimates* are not included in the real-time ancillary service adjustment because these resources are not moved off their economic basepoint to account for these reserves.

- PJM will post Balancing Ratios in Excel format on PJM.com under the Capacity Market section in Markets & Operations.
- PJM will post a Preliminary Balancing Ratio within a few business days after a Performance Assessment event occurs.
Will not include the DR Bonus Performance value, PRD Bonus Performance value, and any retroactive capacity replacements.
- The final Balancing Ratio will be posted with the issuance of the first monthly billing of the Performance Assessment event.

Calculation of Expected Performance

Resource Type

Expected Performance

Generation Capacity Resource	Committed UCAP * Balancing Ratio
Demand Resource	Committed ICAP <i>(adjusted to account for linked registrations that were not dispatched)</i>
Energy Efficiency Resource	Committed ICAP
Price Responsive Demand <i>(effective with 2022/2023 DY)</i>	Nominal PRD Value Committed <i>(adjusted to account for any PRD registrations in the Emergency Action Area that were not subject to compliance measurement)</i>
Qualifying Transmission Upgrade	Committed UCAP
Energy-Only Resources	0 MW
Energy Imports	0 MW

Expected Performance during a PAI is calculated based on resource type and CP commitments on the day of PAI.

- Upon request to PJM no later than three business days after a PAI, a retroactive replacement may be permitted under certain conditions.
- Retroactive replacements can occur through retroactive replacement transactions for RPM commitments *and retroactive updates to FRR Capacity Plan for FRR commitments**.
- Retroactive replacements reduce the committed ICAP/UCAP of the resource being replaced and increase the committed ICAP/UCAP of the replacement resource.
- Expected Performance is calculated based on CP commitments that are adjusted for retroactive replacements.

**Note: Existing M-18 language is not clear that FRR Entities may retroactively adjust FRR commitments in their FRR Capacity Plan in a manner comparable to RPM retroactive replacement transactions.*

- **Manual 18, Section 8.8, “Replacement Resources” states:**
 - *“Replacement capacity for generation resources, Demand Resources, Energy Efficiency Resources, or Qualifying Transmission Upgrades committed to RPM may be specified via the Capacity Exchange system by entering a ‘Replacement Capacity’ transaction before the start of the Delivery Day.”*
- Manual language is not clear that FRR Entities may retroactively adjust FRR commitments in their FRR Capacity Plan in a manner comparable to RPM retroactive replacement transactions.



Identified by PJM as an area that would benefit from greater **clarification**

Calculation of Actual Performance

Resource Type	Actual Performance
Generator/Storage	Metered Energy Output + Reserve/Regulation Assignment
Demand Response	Load Reduction + Reserve/Regulation Assignment
Energy Efficiency	PJM Approved Post Installation Load Reduction
Qualifying Transmission Upgrade (QTU)	Committed UCAP value if in service, otherwise 0 MW
Net Energy Imports	Net Energy Imports – Net Energy Exports – Energy from External Generation Capacity Resource. If negative, actual performance is 0 MW.
Price Responsive Demand (PRD) *	The sum of the actual load reduction for PRD registrations measured for compliance

*** Effective in the 2022/2023 Delivery Year**

- Regulation and Reserve calculations for PAI adjustments are involved, and the current Manual and Tariff language lacks details and transparency into these calculations.
 - Need to address the ancillary service and any adjustments from economic dispatch to provide the service
- Tariff Attachment DD 10A c.
 - Actual Performance = for each generation resource the metered output of energy delivered to PJM by such resource **plus the resource's real-time reserve or regulation assignment**, if any, during the PAI.



Identified by PJM as an area that would benefit from greater *transparency*

The regulation adjustment accounts for the regulation signal sent to resources in real-time operations and any additional movement off the economic basepoint to provide regulation.

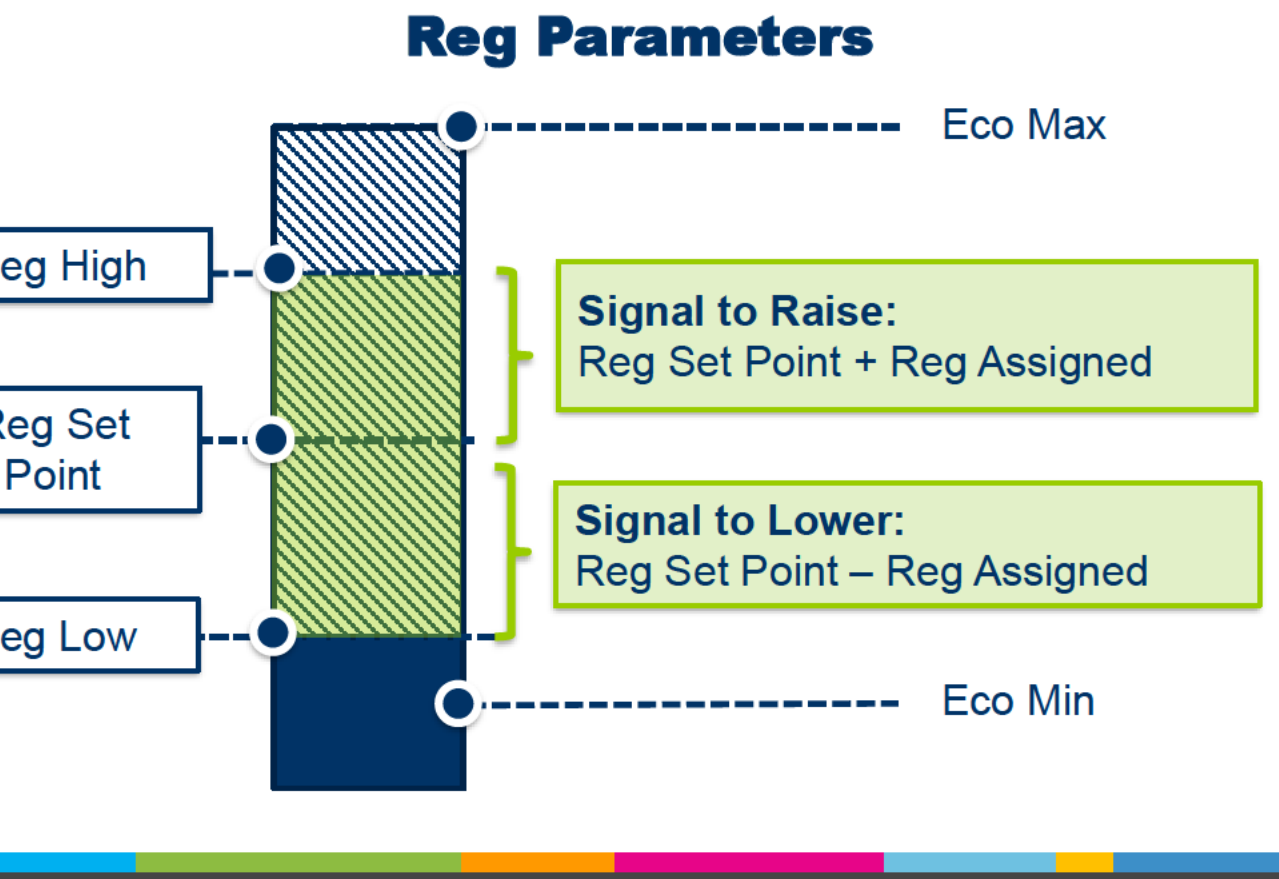
- The real-time operations signal (regulation bias factor) is used as a multiplier to the resource's assignment.
- The adjustments take into account the regulation parameters (regulation high and low limits) to move the resource into the regulation band.
- The calculation does not provide “extra” adjustment if the resource is operating above where they should be for regulation.

Regulation Adjustment =
 $LMP \text{ Desired MW} - \text{Max}(\text{Regulation biased set point, real-time output}), \text{ floored at } 0$

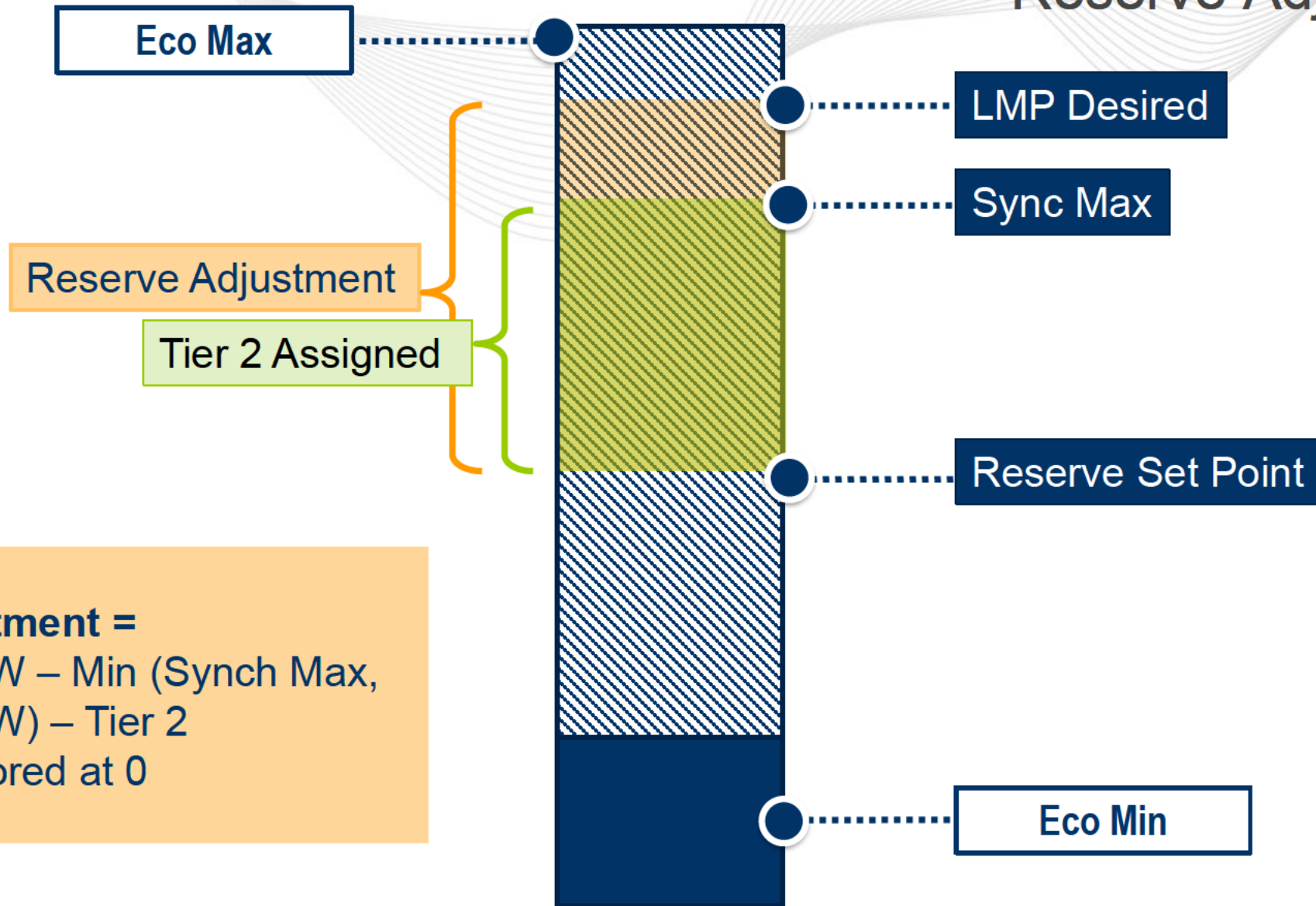
Regulation biased set point =
 $\text{Regulation set point} + \text{real-time Regulation Signal}$

Reg Bias

- Real-time regulation signal = Assignment * Reg Bias
- Reg Bias = Absolute value of signal being requested in RT



- The reserve adjustment accounts for the Tier 2 reserve MW being held by the resource and any additional headroom off the economic set point to account for the spin max of the resource.
 - Calculation adjusts for moving resource off economic basepoint to reserve MW for reserves
 - Calculation takes into account unit's spin max capability
 - Calculation does not provide "extra" adjustment if the unit is operating above the reserve set point (and not holding enough reserves for Tier 2 assignment)
- Tier 1 reserve MW are not adjusted, due to those units being dispatched economically and not being moved to provide reserves.



Reserve Adjustment =
LMP Desired MW – Min (Synch Max,
LMP Desired MW) – Tier 2
Assignment, floored at 0

The calculated regulation adjustments and reserve adjustments are added to the Metered Output to calculate the Actual Performance MW.

Calculation of Initial Performance Shortfall

Initial Performance Shortfall =



- **Positive number** indicates potential under-performance (shortfall)
- **Negative number** indicates potential over-performance (Bonus Performance)

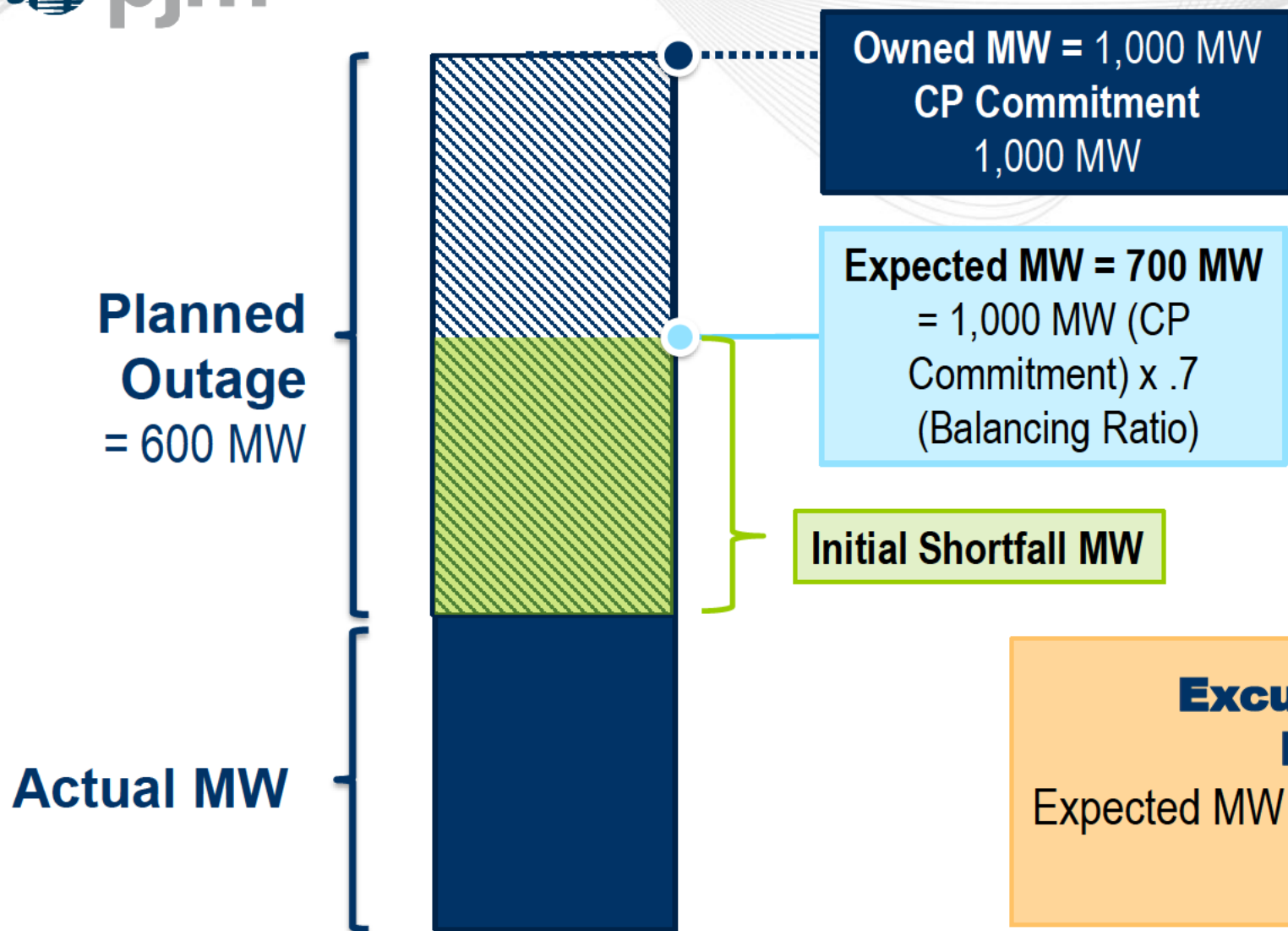
- Calculate an initial performance shortfall for each Performance Assessment Interval (PAI) and PAI Area separately.
- For a generation resource, a positive initial performance shortfall may be adjusted downward due to Excused MW.

Calculation of Excused MW

- Shortfall MW may be Excused from Non-Performance Assessments based on the language in OATT, Attachment DD, Section 10A (d) and Manual 18, Section 8.4A.
- Excused MW may be granted if:
 - Resource was on a Generator Planned Outage or Generator Maintenance Outage approved by the Office of the Interconnection (Excused MW due to Outages).
 - Resource was not scheduled to operate, or was online but was scheduled down based on a determination by PJM that it was appropriate to the security-constrained economic dispatch of the PJM Region (Excused MW due to SCED).

- Outage information is obtained from eDART.
- Planned Outage MW is allocated using pro rata shares of Installed Capacity in the event modeling differences exist between eDART and Capacity Exchange.

Excused MW Due to Planned or Maintenance Outage =
Expected MW – Maximum (Owned MW – Planned Outage MW, Actual MW)



Unit's Actual MW	Initial Shortfall MW	Excused due to outage MW
375	325	300
400	300	300
425	275	275

Excused MW due to Planned or Maintenance Outage =
 Expected MW – Max (Owned MW – Planned Outage MW, Actual MW)

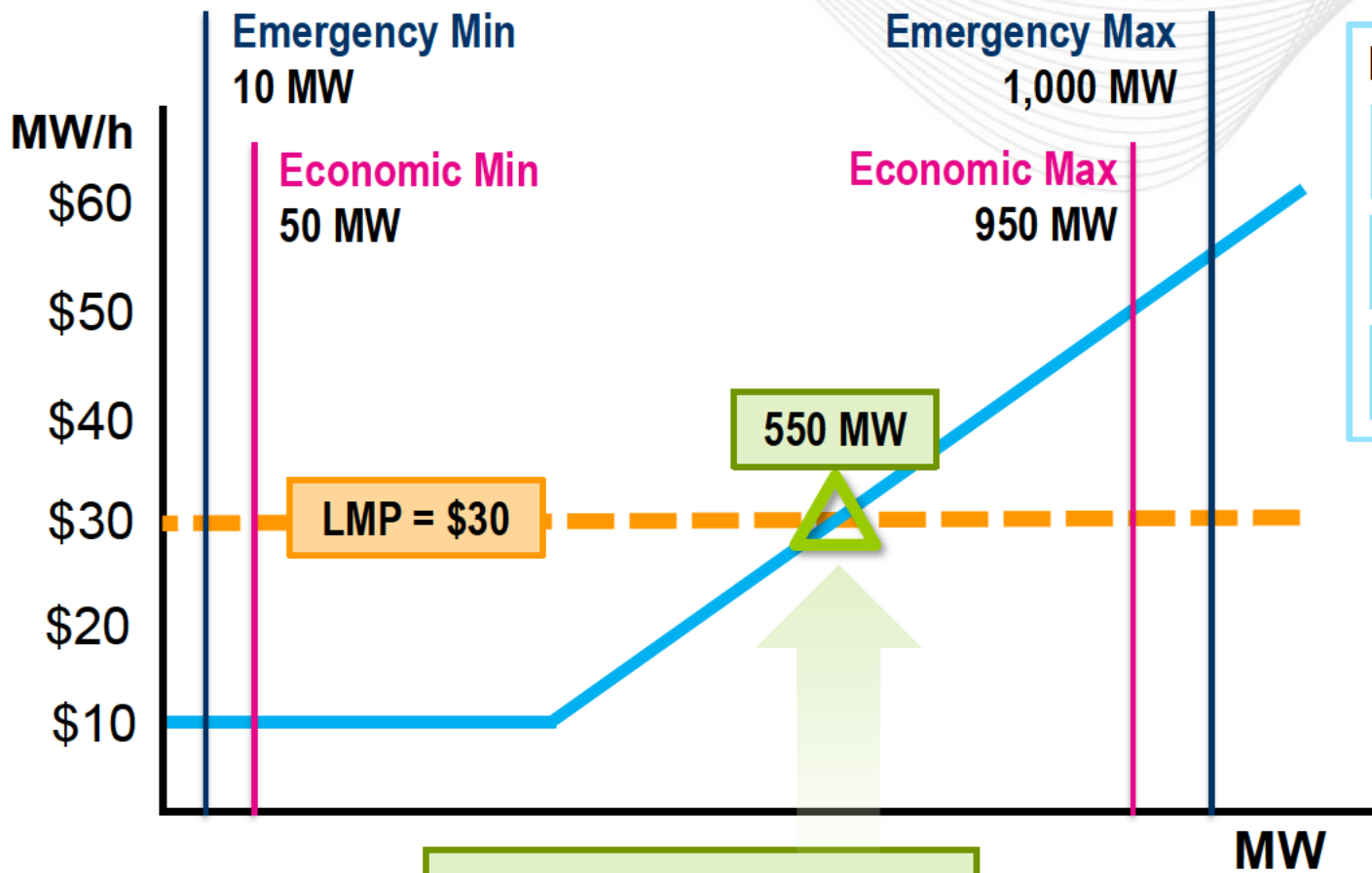
- In cases where PJM operators manually dispatched a unit uneconomically to a lower operating level, PJM uses override values to adjust the unit's scheduled MW value to the requested dispatch value.
- Requested dispatch value is then captured in the equation for *Excused MW due to SCED*.

- A generation resource's initial positive Performance Shortfall may be adjusted downward if it was not scheduled to operate by PJM or was scheduled down by PJM based on the determination by PJM that it was appropriate to the security constrained economic dispatch of the PJM region.
- However, the Tariff prohibits excusal of MW if the resource was needed by PJM and would otherwise have been scheduled by PJM to perform, but was not scheduled to operate, or was scheduled down solely due to:
 - Any operating parameter limitations submitted in resource's offer, or
 - Submission of market-based offer higher than cost-based offer



Identified by PJM as area that would benefit from greater *transparency*

- To ensure MW that were not scheduled or were scheduled down due to operating parameter limitations are not excused, PJM calculates an after-the-fact scheduled MW.
- The basepoint communicated to the resource during the PAI cannot be considered as the scheduled MW because it is influenced by the operating parameters submitted in the resource's offer (e.g., ramp rate, Economic Maximum, Startup Time, etc.).
 - PJM did seek FERC approval to allow consideration of Ramp Rate in the calculation of scheduled MW, but FERC rejected the filing (see: Docket ER16-1336-000).



Incremental Offer Curve:

- Segment 1: 0 MW @ \$10/MWh
- Segment 2: 400 MW @ \$10/MWh
- Segment 3: 1,100 MW @ \$60/MWh

△ When LMP = \$30,
Scheduled MW = 550 MW

To calculate the Scheduled MW for the Penalty calculation, the five-minute LMP applicable to the PAI interval is used to determine the scheduled MW for each available schedule, adjusted for the unit's bid in economic and emergency limits.

PJM ensures MW that were not scheduled or were scheduled down due to having a market-based offer greater than the cost-based offer are not excused:

- If a unit was dispatched on its market-based curve, the highest Scheduled MW quantity for all available schedules is used to calculate the Excused MW due to SCED.
- If a unit was dispatched on its cost-based curve, the Scheduled MW value for that cost-based schedule is used to calculate the Excused MW due to SCED.

After the Scheduled MW is calculated and the effect of market-based and cost-based offers is considered, the excused MW due to SCED can be calculated.

Excused MW due to SCED =

Minimum

Resource Emergency Max MW
 Expected MW
 Owned MW adjusted for Outage MW

What the unit could *have/should have produced*

Maximum

Scheduled MW
 Actual Performance MW

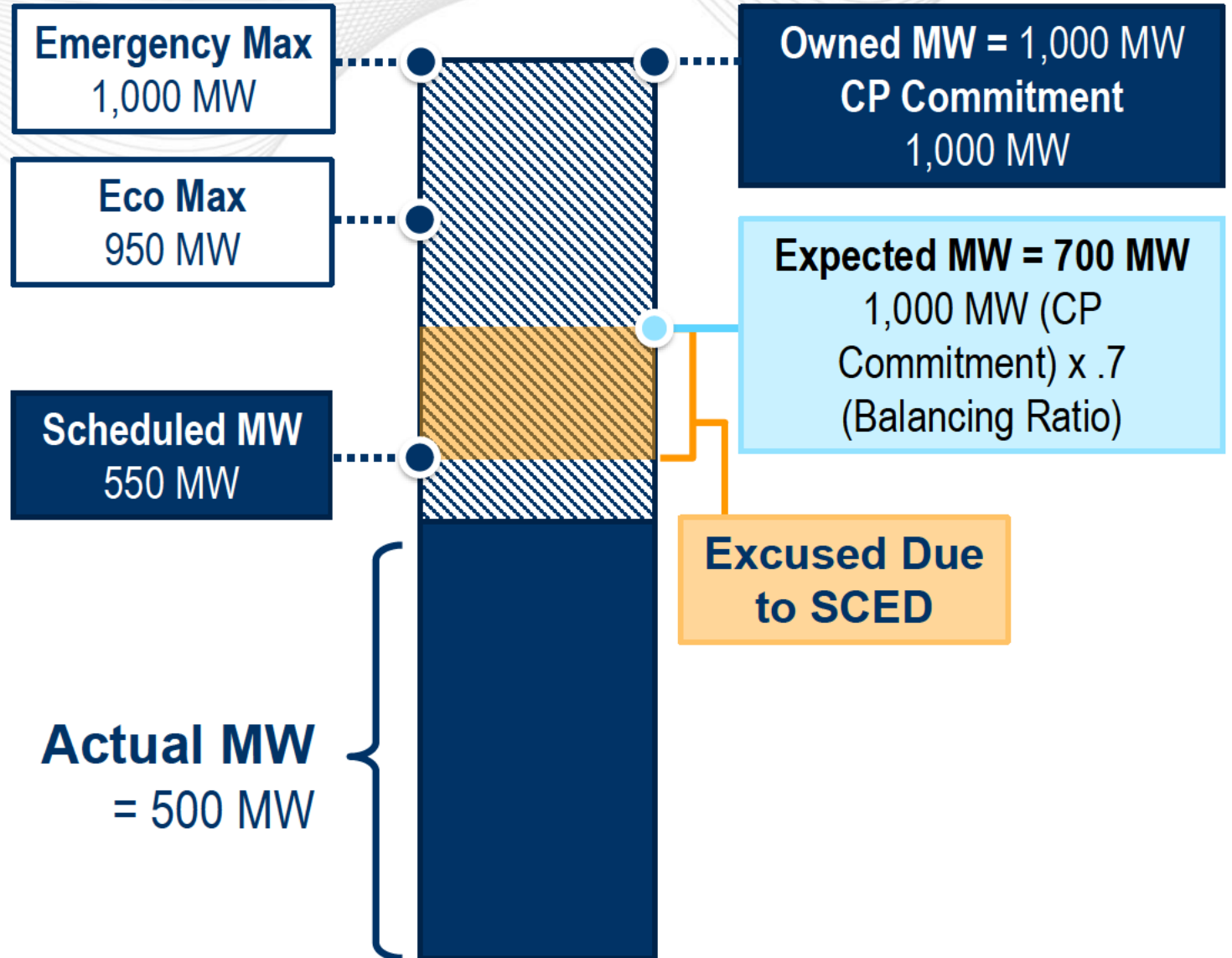
What the unit *produced/scheduled to produce*

Excused MW Due to SCED – Example

Excused Due to SCED =

Minimum of	Minus maximum of
<ul style="list-style-type: none"> • Resource Emergency Max MW • Expected Performance MW • Owned MW adjusted by Outage MW 	<ul style="list-style-type: none"> • Actual Performance MW • Scheduled MW

= Min (1,000, 700, 1000) – Max(500, 550)
= 150 MW



Allocation of Excused and Actual Performance to Capacity Resources Due to Modeling Differences

Manual 18, Section 8.4A states that the metered output of jointly owned generation resources is allocated to each owner pro rata with each owner's share of the total Installed Capacity of the resource.

- Clarify outages are included in the calculation, if applicable.
- Clarify calculations also used for modeling differences.
- Include details on all calculations that use the same methodology.



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PAI settlement calculations require inputs from various PJM tools.

Capacity Exchange

CP Commitments and
Installed Capacity

Markets Gateway/Power Meter

- Actual Generation
- Regulation
- Synchronized Reserves
- Non-Synchronized Reserve
- Unit parameters

eDART

Planned, Maintenance
and Forced Outages

The following scenarios must be accounted for in the PAI settlements:

Joint Ownership

Generator model differences across tools/markets

Examples include:

- Multiple capacity resources aggregated into a single unit for energy and ancillary service markets or vice versa
- Different number of resources modeled in capacity market as compared to energy and ancillary service markets
- Modeling differences can exist between eDART, Markets Gateway, and Capacity Exchange

Planned Outage MW	Actual Performance MW	Capacity Market Ownership	Owned MW	Allocated Planned Outage MW	Owned MW Adjusted by Outages	Allocated Actual Performance MW
6	10	Company A	5	1.5	3.5	2.5
		Company B	15	4.5	10.5	7.5
		Total	20	6	14	10

- Single resource owned by two companies
- Single unit modeled in capacity, energy & ancillary service markets

Allocated Planned Outage MW =

Planned Outage MW * (Owned MW / Total Owned MW)

Allocated Actual Performance MW =

Actual Performance MW * (Owned MW adjusted by outages / Total Owned MW adjusted by outages)

Calculation methodology applies to:

- Unit parameters
- Scheduled MW for penalty
- Ancillary service market inputs
- Schedule MW for bonus

Energy and Reserve Markets	Actual Performance MW	Capacity Market	Owned MW*	Allocated Actual Performance MW
CC Unit 1	200	CC Unit 1	100	57
		CT Unit 2	100	57
		CT Unit 3	150	86

**Owned MW also adjusted by outages*

- Multiple capacity resources
- Single unit modeled in energy & ancillary service markets

Allocated Actual Performance MW =
 $\text{Owned MW} / \text{Total Owned MW} * \text{Actual Perf MW}$

Calculation methodology also applies to:

- Unit parameters
- Ancillary service market inputs
- Scheduled MW for penalty
- Scheduled MW for bonus

Calculation of Performance Shortfalls

Initial Performance Shortfall =



- **Positive number** indicates potential under-performance (shortfall)
- **Negative number** indicates potential over-performance (Bonus Performance)

- Calculate an initial resource performance shortfall for each Performance Assessment Interval (PAI) and PAI Area separately.
- For a generation resource, a positive initial performance shortfall may be adjusted downward due to Excused MW.
- Bonus Performance is capped at the Scheduled MW.

- OATT, Attachment DD, Section 10A (g) caps the Actual Performance used in the calculation of Bonus at the scheduled MW level
- Scheduled MW for Bonus purposes calculated similar to the calculation of scheduled MW for Penalty, however:
 - Only the offer curve the unit was dispatched on is used in the calculation. There is not a comparison of all submitted schedules.
 - The unit's bid in economic limits are used to cap or floor the scheduled MW unless PJM issued an Emergency Procedure that allows for dispatch in the Emergency range.



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Shortfall MW =



- Total Excused MW applies only to Generation Capacity Resources
- If Shortfall MW \leq 0 MW, final Shortfall MW will equal 0 MW
- If Shortfall MW $>$ 0, final Shortfall MW will be subject to Non-Performance Charge

- Netting of the performance of Generation and EE resources is not allowed.
- Netting of the performance of all seller's Demand Resources located in the PAI and PAI area is permitted.

Netting of Demand Resource Shortfalls

Initial Shortfall MW =



- All positive Initial Shortfall MW for all of the seller's Demand Resources located in the PAI area are netted to determine a Total Portfolio Initial Shortfall MW.
- All negative Initial Shortfall MW for all of the seller's Demand Resources located in the PAI area are netted to determine a Total Portfolio Initial Bonus MW.

Net Performance Shortfall MW =

Total Portfolio
Initial Shortfall



Total Portfolio
Initial Bonus MW

- A positive Net Performance Shortfall MW is allocated to all of the seller's Demand Resources located in the PAI area that had a positive Initial Shortfall MW.
- A negative Net Performance Shortfall MW is allocated to all of the seller's Demand Resources located in the PAI area that had a negative Initial Shortfall MW.

Allocated Shortfall MW =

$$\begin{array}{ccc} \text{Seller's Positive Net Performance Shortfall} & \times & \text{Demand Resource's Initial Shortfall MW} \\ & & \div \\ & & \text{Total Portfolio Initial Shortfall MW} \end{array}$$

- A Demand Resource with an Allocated Shortfall MW is subject to a Non-Performance Charge.
- Allocated Shortfall MW is the final Shortfall MW for the Demand Resource.

Allocated Bonus MW =



- A Demand Resource with an Allocated Bonus MW is eligible for Bonus Performance Credits.
- Allocated Bonus MW is the final Bonus MW for the Demand Resource.

Allocation of Shortfall Between RPM and FRR Commitments

- **RAA Schedule 8.1C** is silent on cases when an FRR Entity has both RPM and FRR commitments:

The FRR Entity must elect whether it seeks to be subject to the Non-Performance Charge for Capacity Performance Resources [...] or to physical non-performance assessments [...]

- Clarify that the election is limited to the FRR commitments of an FRR Entity's Capacity Resources.
- Clarify that any RPM commitments are subject to the Non-Performance Charge and may not be included in the physical non-performance assessment for the FRR Entity's FRR commitments.
- Clarify the method used to allocate the final performance shortfall/bonus MW by commitment type.



Identified by PJM as an area that would benefit from greater *clarification*

RPM Shortfall/Bonus MW =

$$\text{Final Shortfall/Bonus MW} \times \text{RPM CP Committed MW} \div \text{Total CP Committed MW}$$

FRR Shortfall/Bonus MW =

$$\text{Final Shortfall/Bonus MW} \times \text{FRR CP Committed MW} \div \text{Total CP Committed MW}$$

If a resource has both RPM and FRR Commitments, final Shortfall MW or Bonus MW will be allocated pro-rated based on commitments.

Non-Performance Charge Calculation

Committed resource with a positive Final Shortfall MW for PAI/PAI Area is subject to **Non-Performance Charge =**

**Final Shortfall
MW for PAI/PAI
Area**



**Non-Performance
Charge Rate
(\$/MW-interval)**

Non-Performance Charge Rate is based on yearly Net CONE (for CP commitments), a divisor (i.e., an assumed 30 Emergency Action hours per year), and the number of Real-Time Settlement Intervals in an hour.

Non-Performance Charge Rate for shortfall due to CP commitments (\$/MW-interval) =
[(modeled LDA Net CONE (\$/MW-day in ICAP terms) for which the resource resides *
number of days in DY)/30]/number of Real-Time Settlement Intervals in an hour.

If LDA Net CONE = \$300/MW-day,

the Non-Performance Charge Rate =

$[(\$300/\text{MW-day} * 365 \text{ days})/30]/12 = \$304.17/\text{MW-interval}$

**Modeled LDAs and respective Net CONE values are provided in DY
BRA Planning Parameters posted on Capacity Market (RPM) web page.**

Greater of Provisions and Stop Loss

- In addition to Non-Performance Charges, Capacity Resources may also be subject to other performance charges/penalties throughout the year.
 - Capacity Resource Deficiency Charge (Gen, DR, EE)
 - Transmission Upgrade Delay Penalty
 - Generator Rating Test Penalty
- To avoid a double penalty, a greater-of provision applies if the resource was also subject to a Non-Performance Charge during one or more PAIs occurring during a continuous time period of a commitment/upgrade delay/testing shortfall.

- A resource subject to a Non-Performance Charge during one or more PAIs occurring during a continuous time period of a commitment/upgrade delay/testing shortfall shall be assessed a charge equal to the greater of:
 - Total daily charges or penalties for commitment/upgrade delay/testing shortfall during such continuous time period, or
 - Total Non-Performance Charges calculated for the PAIs occurring during such continuous time period
- The sum of the daily Capacity Resource Deficiency Charges/Upgrade Delay Penalties/Generation Rating Test Penalties and Non-Performance Charges actually billed for such continuous time period may not exceed the resultant greater-of charge.

- Stop-loss provisions limit the total Non-Performance Charge that can be assessed on each Capacity Resource.
- **The maximum yearly Non-Performance Charge =**
 $1.5 * \text{Applicable LDA Net CONE} * 365 \text{ days} * \text{max daily CP UCAP MW}$
 commitment from June of the Delivery Year through the end of the billing month for which the Non-Performance Charge was assessed.

Stop-loss for Seasonal Capacity Performance Resource considers the number of days in the applicable season .

Non-Performance Assessment Billing

If a PAI occurs in June, charges and credits will be billed starting with the September bill through the May bill.

Delivery Year												Delivery Year + 1		
June	July	August	September	October	November	December	January	February	March	April	May	June	July	August
June														
	July													
		August												
			September											
				October										
					November									
						December								
							January							
								February						
									March					
										April				
											May			

- Performance Assessment Interval Occurs
- Non-Performance Charge/Bonus Performance Credit in Monthly Bill*

*Monthly bill is issued on the 5th business day following the end of the billing month

- Revenue collected from payment of Non-Performance Charges is distributed to resources (of any type, even if they are not Capacity Resources) that perform above expectations during each PAI.
 - The credit is based on the ratio of its Bonus Performance quantity to the total Bonus Performance quantity (from all resources and PRD Providers for the same PAI).
- The Buyer of Auction-Specific MW Transactions receives any Capacity Performance credits related to the resource(s) identified in the transaction that over-perform during a PAI.
 - Based on the ratio of the resource's cleared MW (in UCAP) transferred in the Transaction to the greater of the a) resource's cleared UCAP transferred or b) Seller's Owned UCAP position for the resource.

$$\begin{aligned}
 & \text{Bonus Performance Credit} \\
 &= \left(\frac{\text{Org Bonus Performance MWs for the interval}}{\text{PJM Total Bonus Performance MWs for the interval}} \right) \\
 & \times \text{Non Performance Monthly Charge for the interval}^*
 \end{aligned}$$

Allocation Of Bonus Dollars

Total Monthly Allocation of Non-Performance Charges for the Interval	\$15,000.00
Org Bonus Performance MW for the Interval	10
Total Bonus Performance MW for the Interval	100
Org Monthly Bonus Dollars for the Interval	\$1,500.00

**Note: PJM will only allocate the total amount of charges received each month*

Presenters:
Danielle Croop,
danielle.croop@pjm.com

Susan Kenney,
susan.kenney@pjm.com

Sean Flamm,
sean.flamm@pjm.com

**Clarification to Performance
Assessment Interval Agreement
Language – Issue Charge**



Member Hotline

(610) 666 – 8980

(866) 400 – 8980

custsvc@pjm.com