Regulation Market Redesign Phase 1
Lost Opportunity Cost Manual 11 Clarification

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Markets and Reliability Committee
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Key Takeaways

- During our final quality assurance review for the Regulation market redesign phase 1 project, it was discovered that the regulation set-point utilized in the new Regulation LOC code is not clearly defined in the business manual, M-11
- Intent is to utilize a **tracking** value for the regulation set point in the pricing run (LPC) only
  - the regulation set point logic (effective Oct. 1) is consistent with the intent approved by the RMDSTF and FERC
- Seeking same day endorsement of adding “tracking” to M-11 to memorialize intent of phase 1 changes

Background

- **Regulation**: the capability of a specific resource with appropriate telecommunications, control and response capability to increase or decrease its output in response to a regulating control signal to control for frequency deviations
- **2022-2023:** The Regulation Market Design Senior Task Force (RMDSTF) addressed regulation market design flaws and potential enhancements including regulation signal design, regulation performance scoring, regulation requirement, regulation market clearing and regulation market settlement
- **Benefits** of the FERC approved Regulation Market updates are anticipated to create efficiencies in procurement and price formation for regulation service while meeting the challenges presented by the changing resource mix (increase in renewable resource types) over the next few years

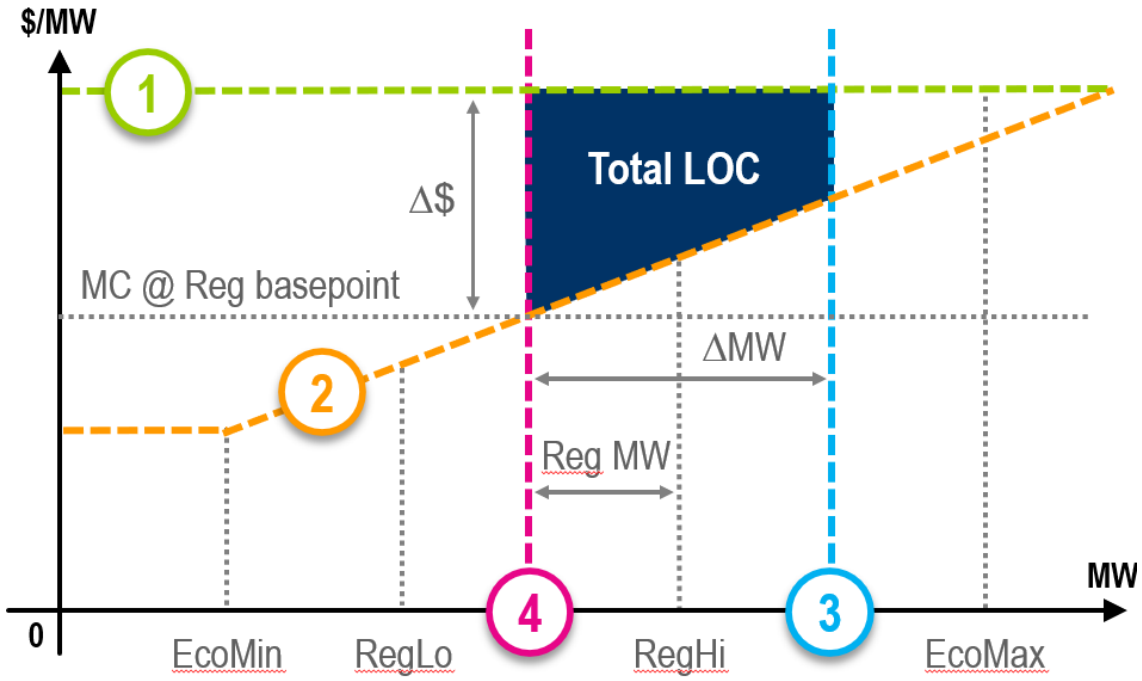
Phase 1 Summary of Changes

#	Design Components	Summary Description
1	**Signals and Products**	Change from ***two*** signals (RegA and RegD) bidirectional to ***one*** signal bidirectional that all resources that are assigned Regulation in a given market interval will follow.
2	**Requirement MW**	Changes to better reflect operational needs with consideration both to historic and future system conditions
3	**Performance Scoring**	Change from accuracy, delay and precision to precision only.
4	**Offer and Clearing Timing**	Eliminate "cost increase in VOM" except for Reg-only resources; change from hour clearing and commitment to 30-minute clearing and commitment.
5	**Opportunity Cost Calculation Reform**	1. Use the schedule the resource is running for energy or else the cheaper of available schedule for offline. 2. Use tracking desired megawatt at LMP ramp rate limited. 3. Use the area between LMP and the energy schedule the resource is running on.
6	**Settlement**	For the eligible resources, Settlement will calculate the shoulder interval opportunity cost for two five-minute ramp-in intervals before the resource Regulation operation and two five-minute ramp-out intervals following the resource Regulation operation (currently, three intervals ramp-in and three intervals ramp-out). Also, Settlement will update the calculation for the Regulation Mileage Credit (currently Performance Credit) such that the mileage ratio is equal to (Real-Time Regulation Mileage/Historic Regulation Mileage).

Regulation Lost Opportunity Cost – New Logic

Regulation LOC is the cost of providing Regulation instead of energy

- In determining the five-minute Regulation clearing price, the non-hydro resource specific opportunity costs are equal to the area bounded by:
  - 1. LMP at the resource bus
  - 2. Resource's Final Offer
  - 3. Resource's tracking ramp-rate limited expected output level
    - accounts for the ramp capability of the unit and tracks the unit's expected output if it wasn't providing regulation
  - 4. Resource's regulation set point on the energy schedule curve on which resource is running
    - LPC preserves MW/min ramp for regulation assignment and uses the remaining ramp to move the unit for energy while accounting for the last tracking regulation set point MW as the starting point for the next tracking regulation set point MW



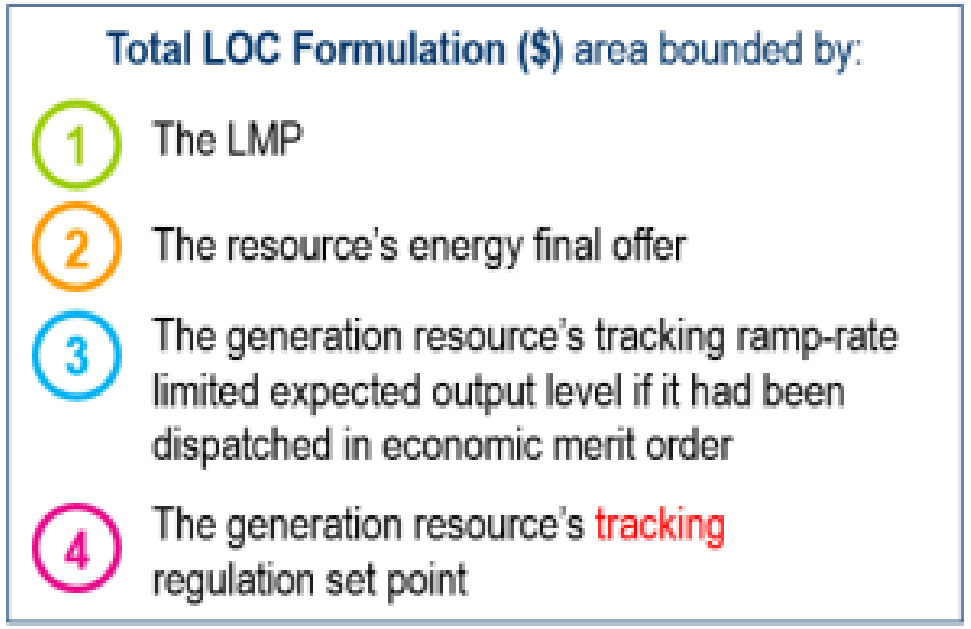
Key Takeaway: Point 4 is also a "tracking value", like point 3, in the pricing run. This is not currently clear in M-11.

Manual Changes

Changes: M-11 (New) Section 3.6.1:

- The Total LOC calculation is derived by first calculating the area bounded by: (1) the Locational Marginal Price (LMP) at the generation bus for the regulating resource, (2) the "Tracking Desired MW at LMP Ramp Limited," (3) the resource's marginal cost at its tracking Regulation set point, and (4) the megawatt value at its tracking Regulation set point.

- Next, the area bounded by: (1) the resource's energy schedule curve, (2) the "Tracking Desired MW at LMP Ramp Limited," (3) the resource's marginal cost at its tracking Regulation set point, and (4) the megawatt at the tracking Regulation set point is removed, leaving the blue shaded geometric area bounded by the resource's Final Offer curve as the calculated LOC as shown in the figure above.



Summary

- Current code, effective October 1, 2025, utilizes the intended tracking regulation set point value

- PJM internal compliance review flagged this input as being ambiguously defined in M-11, (new) section 3.6.1

- Seeking endorsement for M-11 change, no other impacts

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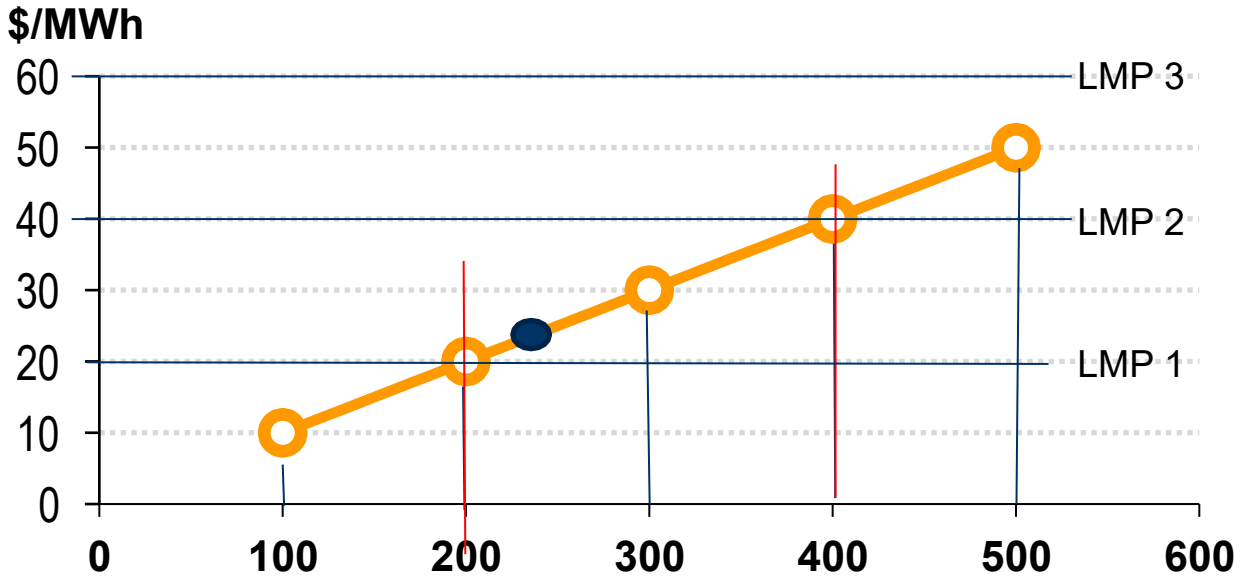
Appendix: Tracking Regulation Set point Example

Tracking Regulation Set point is the expected reference starting megawatt output for which the regulation signal is measured. The value in the next LPC solution uses the value in the last dispatch instruction instead of the unit's actual response.



Consecutive Intervals	1	2	3
LMP ($/MWh)	20	40	60
Economic Energy Target MW @ LMP	200	400	600
Tracking Ramp Limited Desired MW at LMP (MW) – "Point 3"	200	250	300
Tracking Reg Set point (MW) – "Point 4"	225	250	275
Delta MW LOC, MW	25	0	25

Reg = 25 MW	**RegLo =** 200, **RegHi =** 400	**Ramp** 10 MW/Min	Sufficient ramp and reg range

1. Tracking Ramp Limited Desired MW accurately captures the unit's capability and more realistic RegLOC.
2. Tracking Reg Set point accounts for energy ramp capability while regulating
3. Delta MW LOC = abs(Point 3 – Point 4)
4. Tracking approach allows for optimal regulation opportunity cost

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