

Performance, Mileage and the Mileage Ratio

Scott Benner

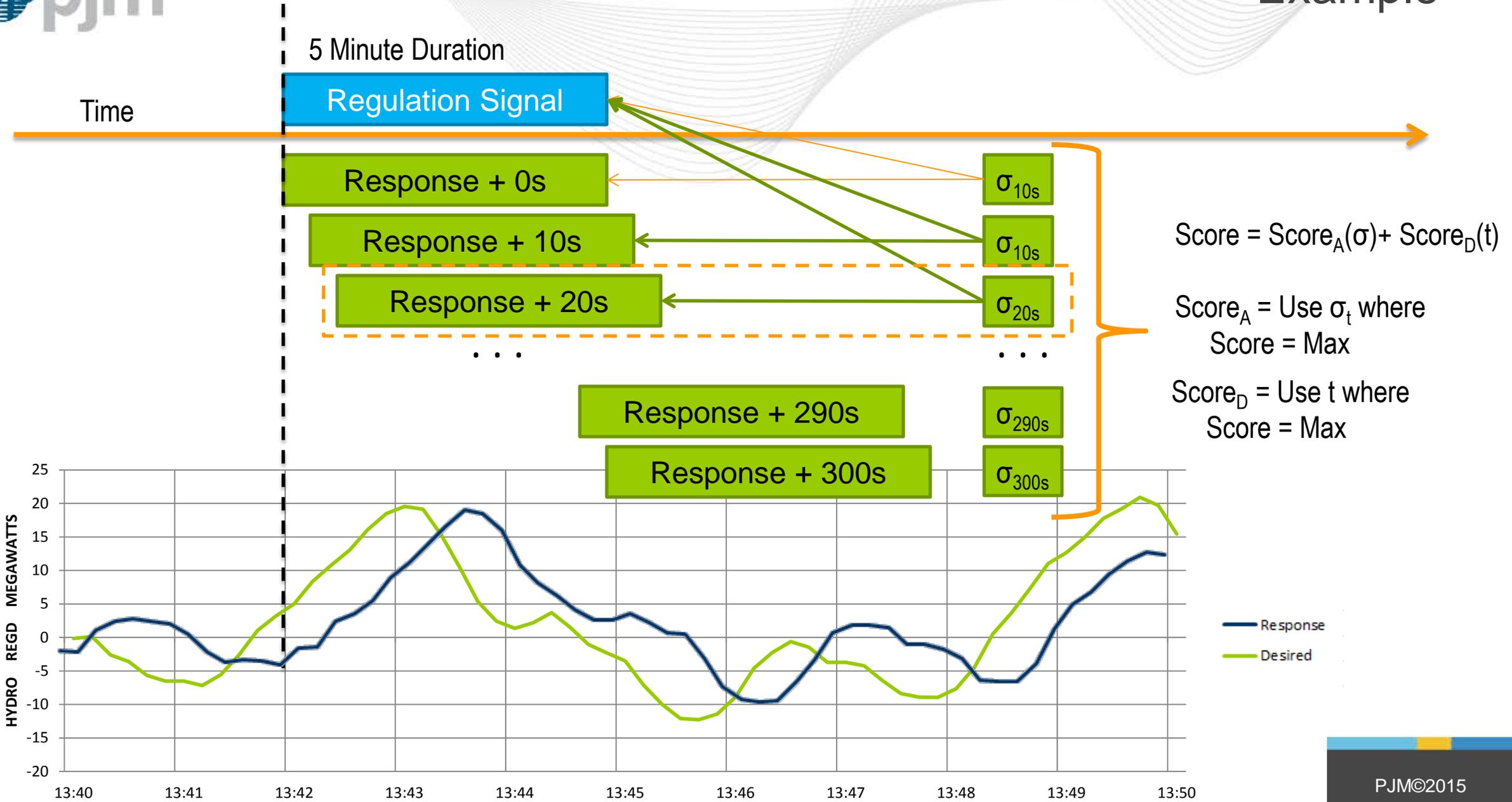
Sr. Engineer – Markets Coordination

Regulation Market Issues Sr. Task Force

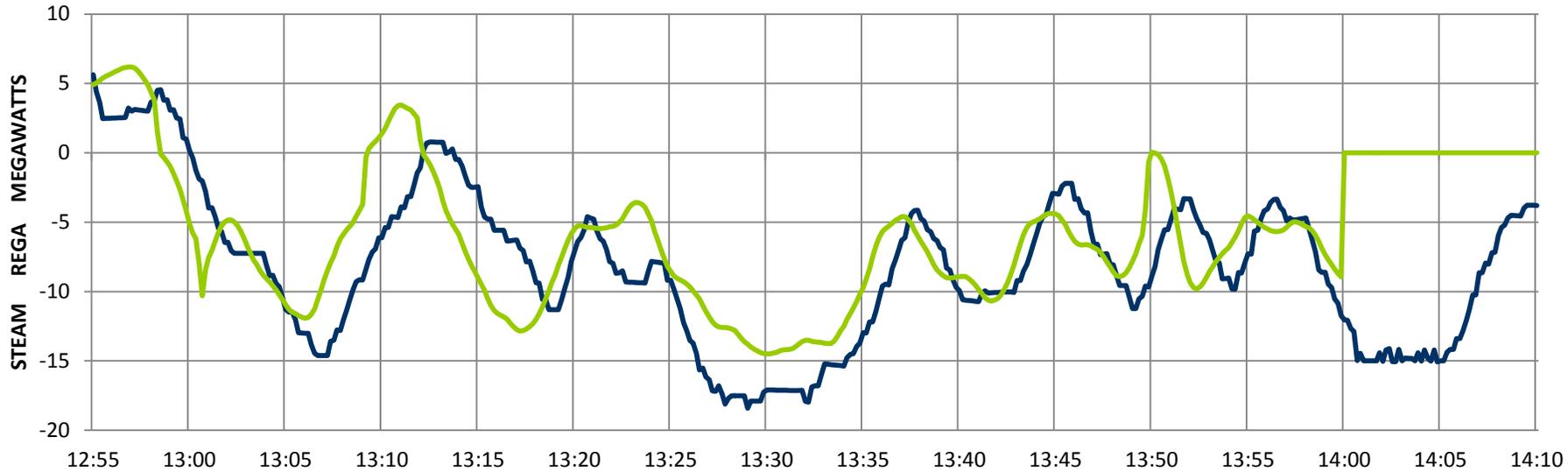
Nov. 11, 2015

- **Performance Scoring**
- **Signal Mileage**
- **Mileage Ratio and Settlements**

- 1) **Accuracy** – the correlation or degree of relationship between control signal and regulating unit's response
 - 5 minute rolling correlation with 10 second granularity
 - Re-calculated with a 10 second time shift up to 5 minutes
 - 2) **Delay** – the time delay between control signal and point of highest correlation from Step 1.
 - Up to 5 minutes
 - 3) **Precision** – The instantaneous error between the control signal and the regulating unit's response.
- **Performance Score = $A [\text{Score}_A] + B [\text{Score}_D] + C [\text{Score}_P]$**
 - A, B, C are scalars from [0..1], total to 1. Currently 0.333 each
 - Produces a weighted average of component scores

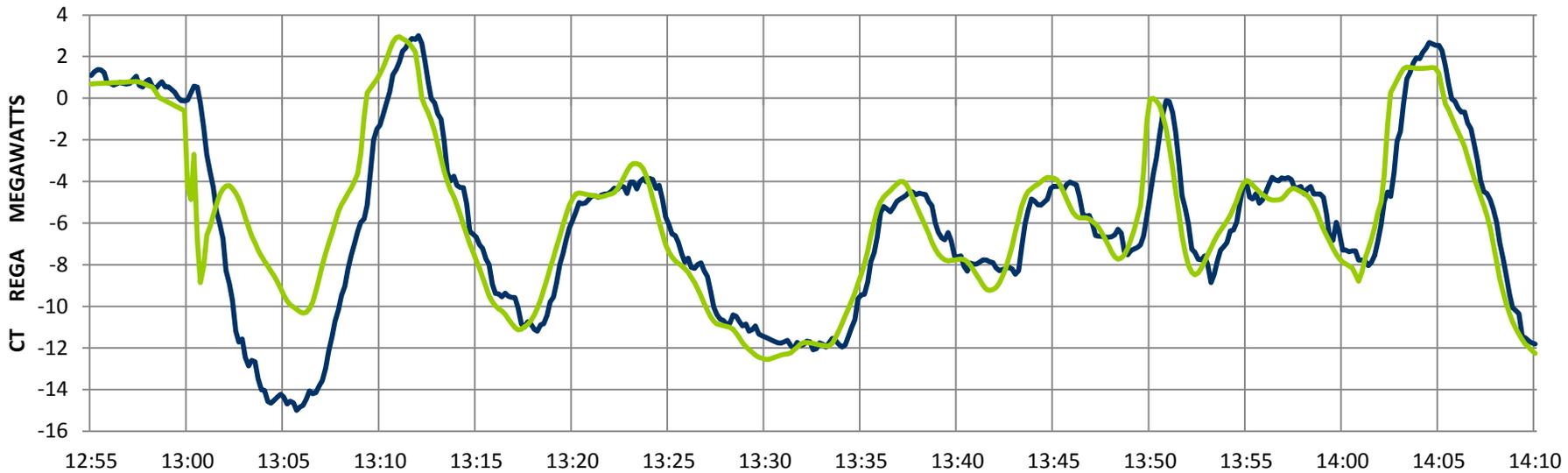


Example Resources Following REGA Signal



Steam
REGA
79.5%

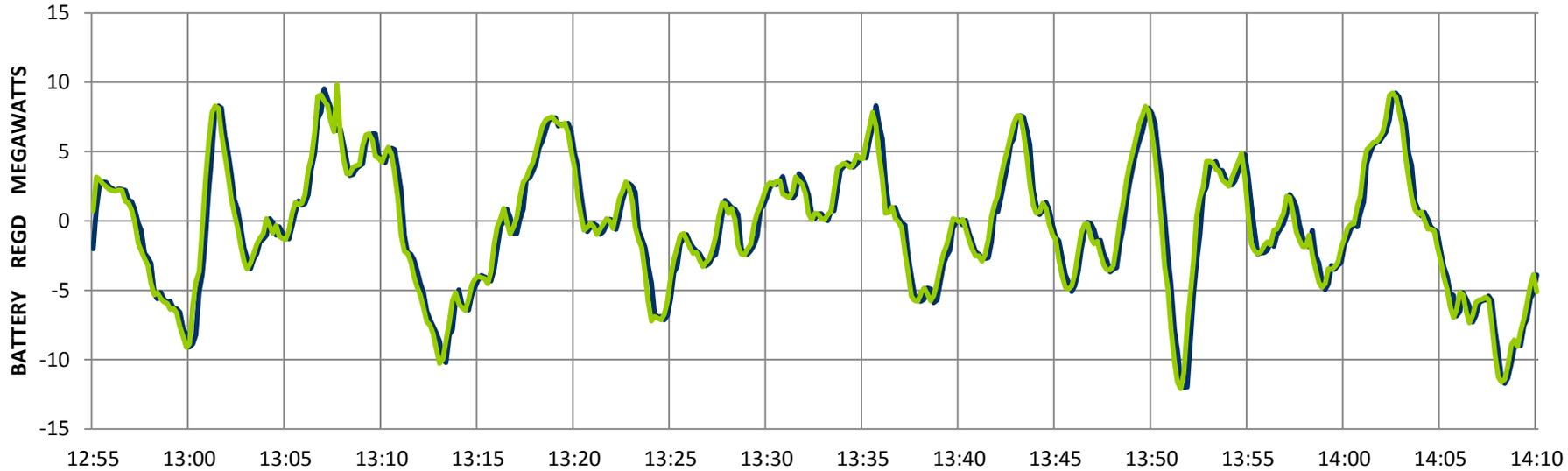
— Response
— Desired



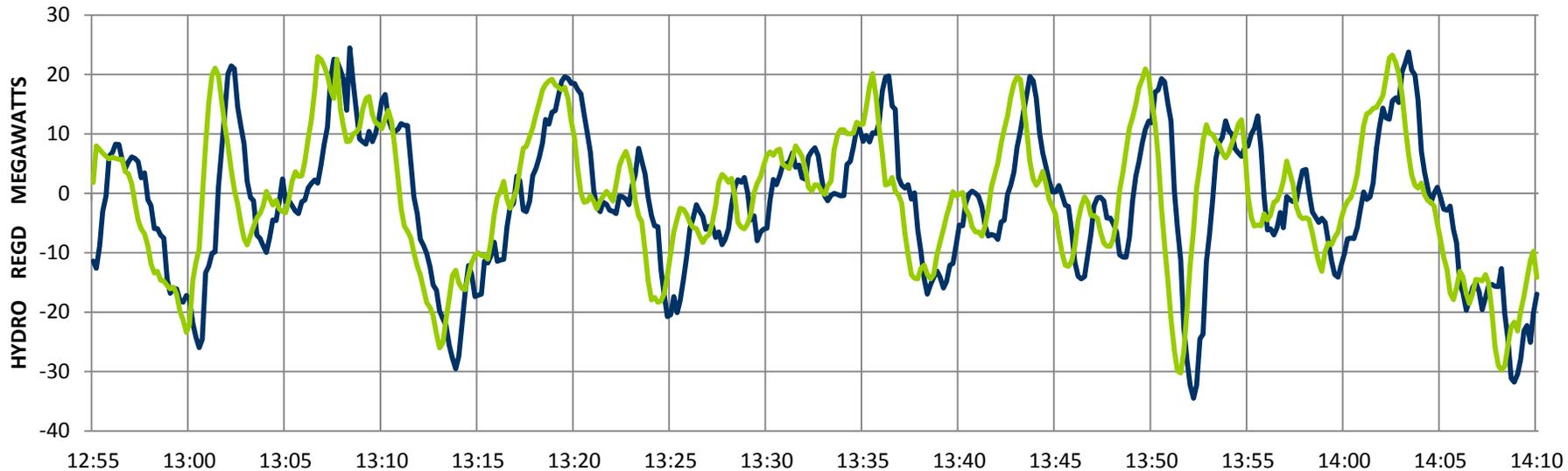
CT
REGA
90.6%

— Response
— Desired

Example Resources Following REGD Signal



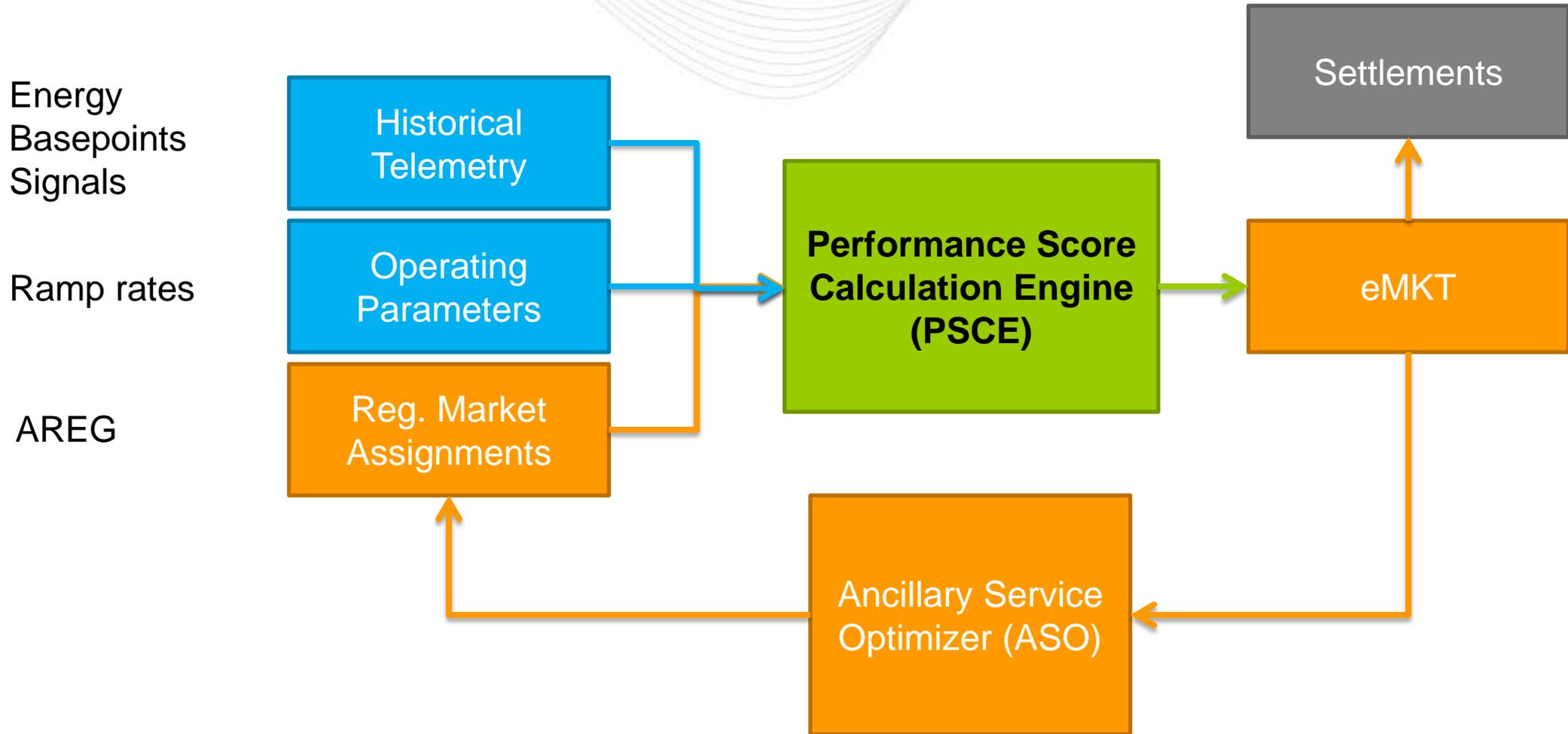
**Battery
REGD
97.7%**



**Hydro
REGD
74.7%**

The Regulation Market **Performance Score Calculation Engine** (PSCE) calculates many things:

- Hourly after-the-fact resource performance scores
- Daily 100-day rolling average resource performance scores
- 5-minute Interval regulation signal mileage
- Hourly regulation signal mileage
- Daily regulation signal mileage



Resources can be scored individually or as groups

- ***Individual***
 - Market resource with distinct actual and desired output (basepoint)
 - Proportionally allocated from the fleet signal
- ***Performance Groups***
 - Many market resources acting as a single virtual resource
 - Hydro plants, distributed generation, DSR
 - Size and configuration requirements, see *Manual 12, Section 4.5.7*

Resource Type	Resource Sub Type	REGA Performance	REGD Performance
GEN	Battery		94.0
GEN	CT	84.4	90.0
GEN	Hydro	79.6	75.7
GEN	Steam	73.6	
DSR	DSR	78.8	84.2

- **Hourly Scores** are calculated and posted to eMKT 15 minutes after the end of the operating hour
 - Used in Settlements for service credits
- At midnight, **Daily Scores** are calculated from the average performance over the last 100 assigned hours
 - Regulation testing date acts as a cutoff; proportional weighting
 - Posted to the NEXT operating day for bid adjustments
 - Used in ASO for hourly clearing of assignments
 - See *Manual 12, Section 4.5.5*

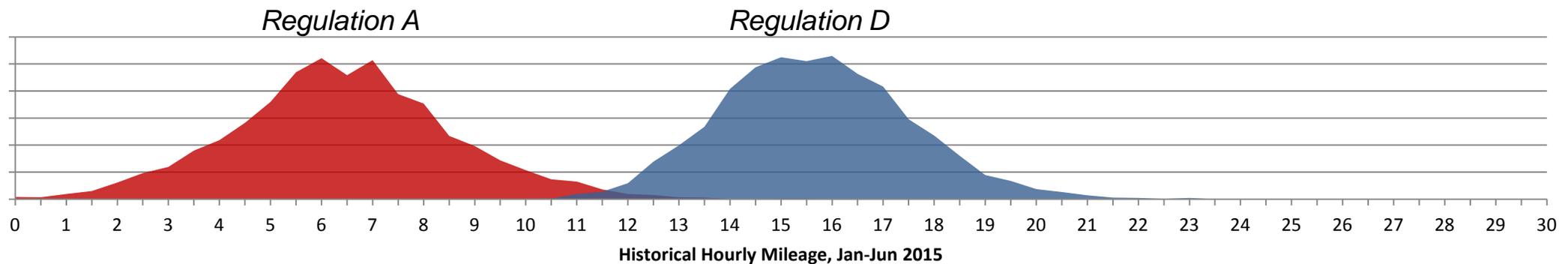
- In Jan 2012, PJM eliminated zonal regulation signals and reduced AGC to two control signals:
 - Regulation A for slower resources that can sustain deviations
 - Regulation D for faster resources that need energy neutrality
 - Both are functions of filtered RTO ACE
 - **Different** gains, time constants, formulation

- **Mileage** is the absolute sum of movement of the regulation signal in a given time period

$$\text{Mileage}_{\text{RegA}} = \sum_{i=0}^n |\text{RegA}_i - \text{RegA}_{i-1}|$$

$$\text{Mileage}_{\text{RegD}} = \sum_{i=0}^n |\text{RegD}_i - \text{RegD}_{i-1}|$$

- Resources following the dynamic signal will move much more than those on traditional signal



- Mileage is the proxy metric for “amount of work” performed
 - Contribution towards ACE correction
- For an hour with 8 mileage, a 1 MW assigned resource will move up and down a total of 8 MW
 - Basepoint to full raise is 1 MW-mile
 - Full raise back to basepoint is another 1 MW-mile
- But . . . Is all movement of a resource “useful work”?

- The Regulation D signal includes an additional term
 - ACE Correcting Signal (ACS) feeds P.I. controller to make RegA
 - RegD starts as residual of ACS – RegA (definition of RegB)
 - Subtract filter of residual with 2-minute time constant
- When regulation desired saturates (full raise or full lower) for more than 2 minutes, REGD will begin to move back to neutral
 - That movement back to 0 MW counts as mileage
- Resources are following the signals they are given, but is PJM sending the “right” signal to correct ACE?

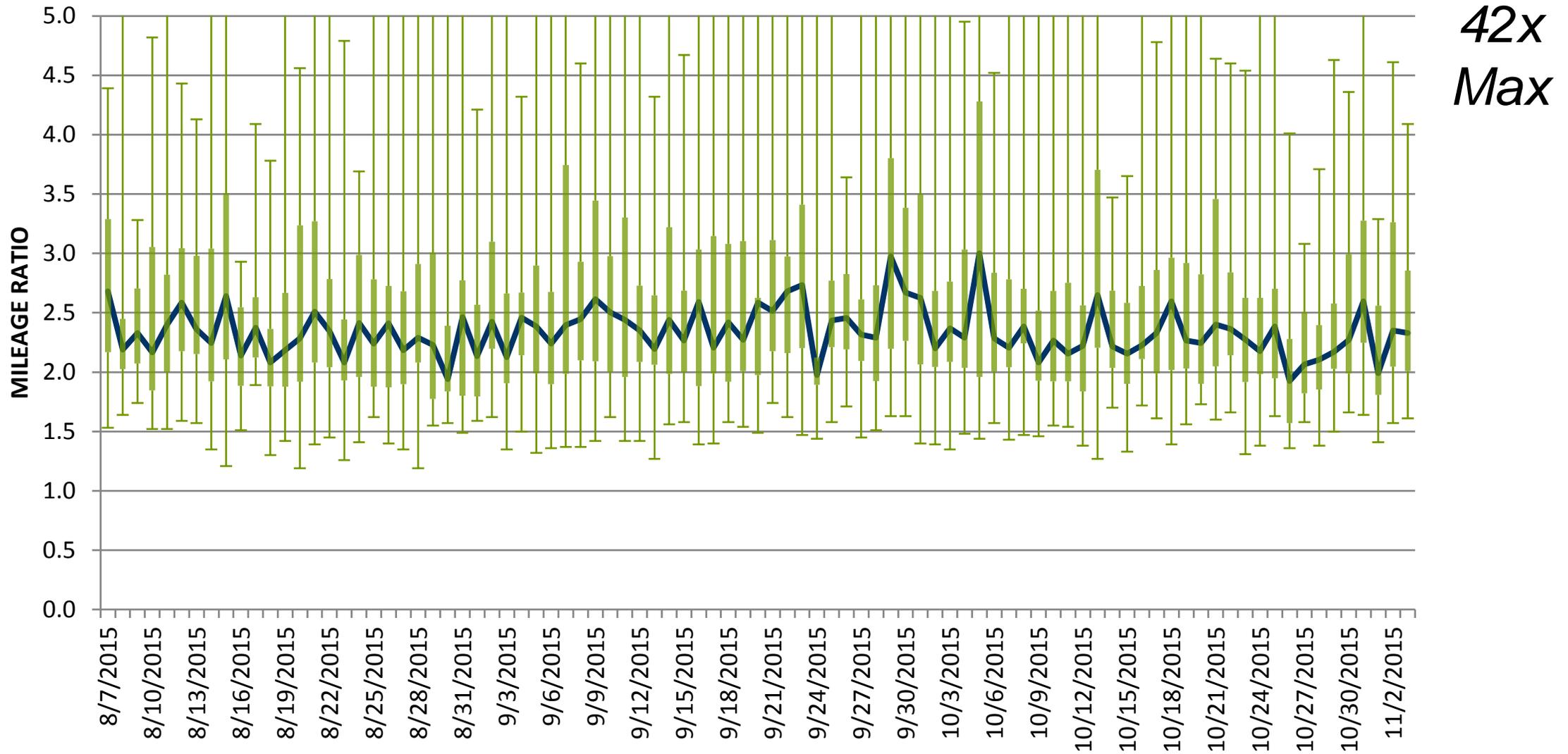
- **Interval Signal Mileage** is calculated every 5 minutes measuring the movement over the previous 5 minutes
 - Used in the co-optimized Energy and Ancillary Service Pricing
 - Real-time pricing of Regulation Market CCP and PCP
- At the top of each operating hour, **Hourly Signal Mileage** is measured for the previous operating hour (actual mileage)
 - Used in Settlements for service credits
- At midnight, **Daily Signal Mileage** is calculated as the average of hourly mileage over the last 30 calendar days
 - Posted at +7 DAYS for bid adjustments
 - Used in ASO for hourly clearing of assignments

- The **Mileage Ratio** is defined as

$$\text{Mileage Ratio} = \frac{\text{Mileage}_{\text{RegA}}}{\text{Mileage}_{\text{RegD}}}$$

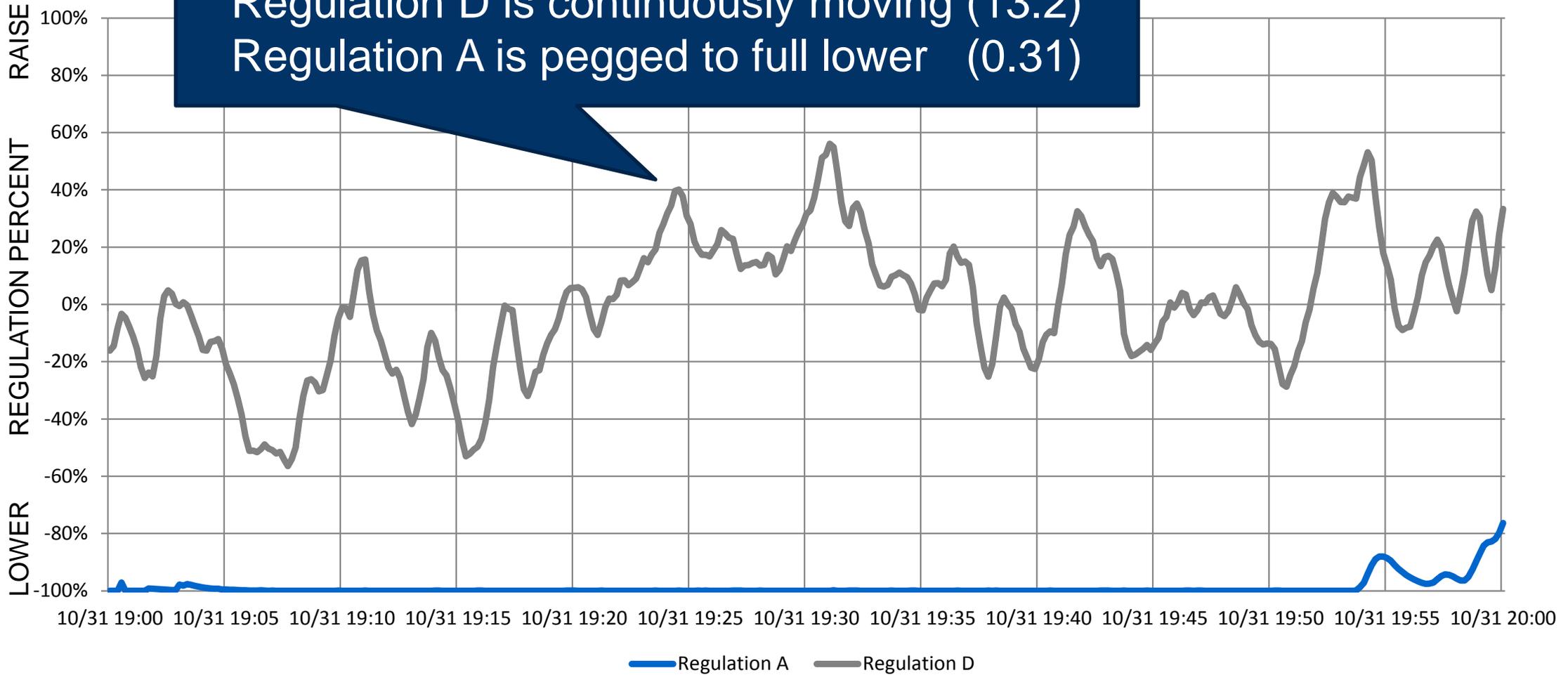
- Measure of the relative work (movement) of Regulation D resources relative to Regulation A (unit-less)
 - Compare movement from signals, responding to correct ACE
 - Does not account for sustained deviation from the basepoint
 - Intended to price the variable costs of providing regulation
 - Cost increase in VOM, Heat Rate from non-steady-state operation
 - See Manual 15 for regulation cost development

RegD/RegA Mileage Ratio, Last 90 Days



Why is the Mileage Ratio So High?

Regulation D is continuously moving (13.2)
 Regulation A is pegged to full lower (0.31)



- **RTO Mileage Ratio** is posted with the daily Real Time LMP
 - **Ancillary Service MCP Data** section at the top of the file
- Resources' hourly credits are calculated using actual (after-the-fact hourly) performance scores and mileage
- Marginal benefit factor will not scale payments
- Minimize additional make whole payments (LOCC)
- See *Manual 28, Section 4.2*

System	Function	Performance Score	Benefits Factor	Mileage
ASO	Clearing	100-Hour Average	✓	30-Day Average
LPC	Pricing	100-Hour Average	✓	5-Min Interval
MSRS	Settlements	Hourly	✗	Hourly Average

- **Performance Score** measures how well a resource follows the signal it is given
- **Mileage** measures how much a regulation signal is moving
- **Mileage Ratio** measures the relative movement requested from regulating resources following different signals