



Regulation Signal and Requirement Update



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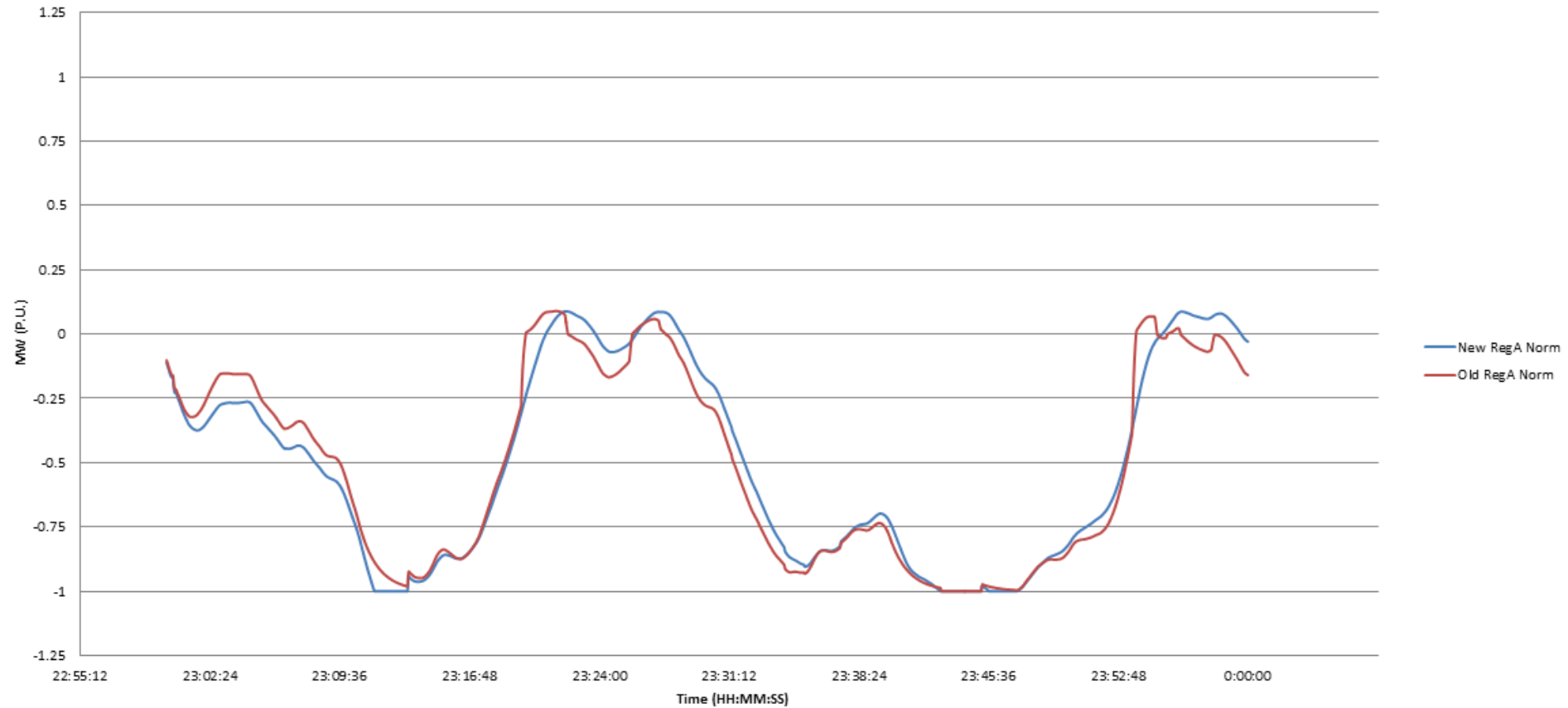
- Signals are providing improvement to ACE control
 - Regulation signals are always controlling ACE
 - Two weeks worth of data, ACE control improvement analysis underway
- Regulation Pegging
 - Most signal pegging was seen on Jan. 9 (implementation date)
 - Jan. 9 was a highest load day to date; morning peak 128,372 MW
 - Signal tuning occurring on gains and payback to optimize controller
 - Mileage ratio 2-3 times higher on average

- Regulation Requirement
 - 800 MW during ramp period helped with system control
 - 525 MW during midday period can be tight depending on system conditions
- Regulation Performance
 - Resource performance close to modeled response
 - Small decrease of performance score on average for Reg D resources, some resources have larger impact than others
 - Reg D resources are adapting to the new signals
 - Need to revisit use of regulation parameters (i.e. load basepoint)

The **Conditional Neutrality** controller:

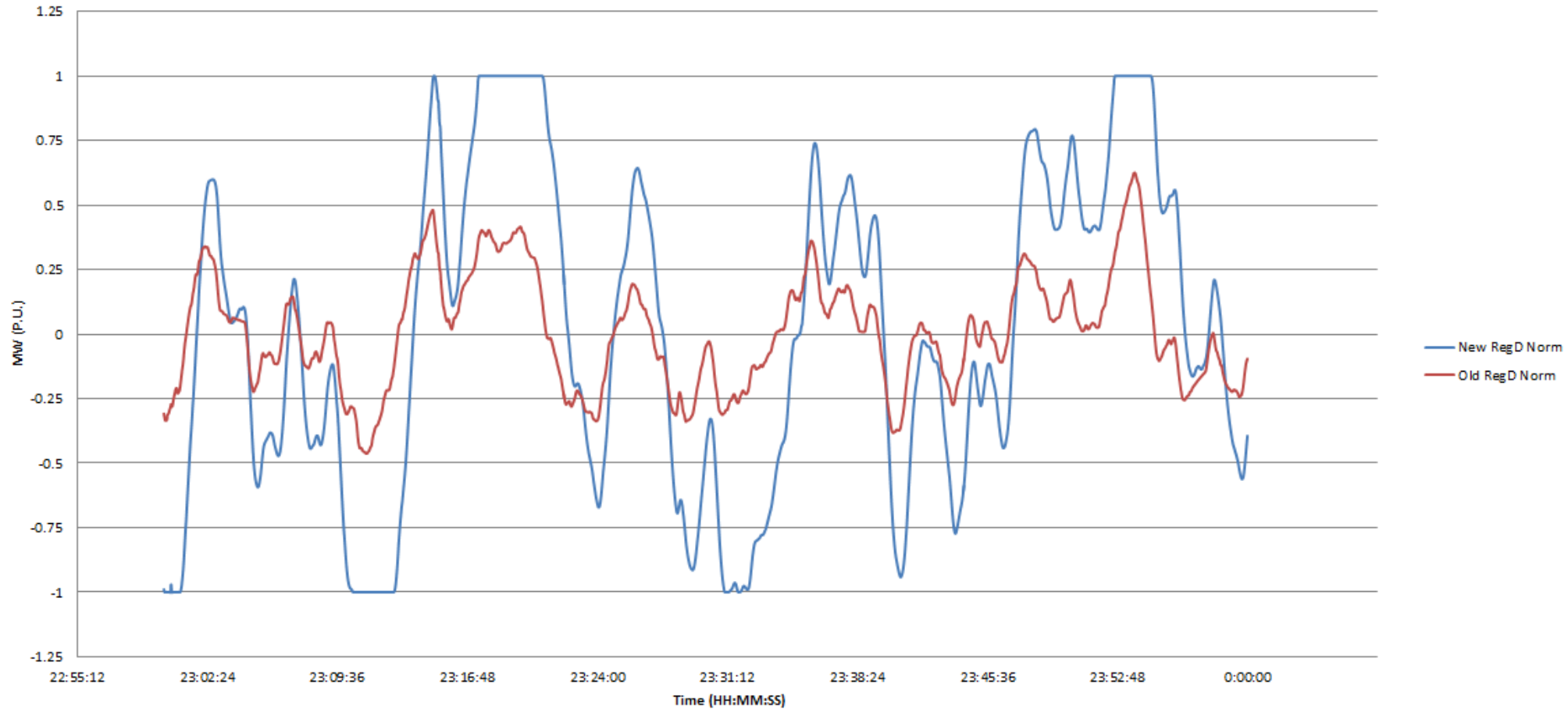
- Slows the Reg A signal
- Utilizes the full range of Reg D
- Removes old Reg D neutrality logic
- Tracks historical Reg D utilization
- Uses all of Reg D for ACE control
- Biases Reg A to “recharge” Reg D after pegging events

New Vs Old RegA

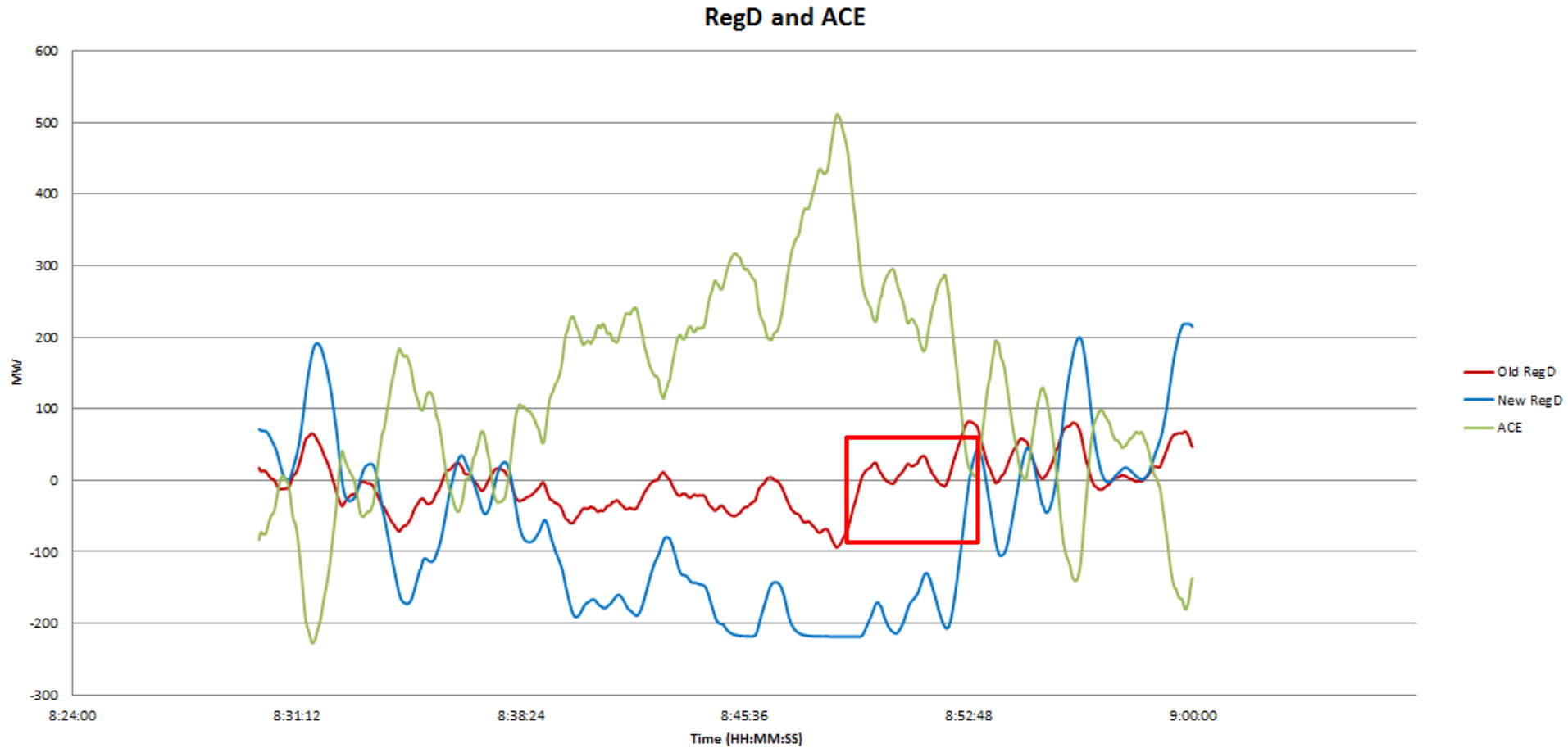


- Slowed the Reg A signal in order to closer align with unit ramp

New Vs Old RegD



- Reg D resources are fully utilized to control ACE



- Reg D resources follow ACE control rather than going in opposite direction of ideal control

Season	Dates	Off-Ramp Hours	On-Ramp Hours	Benefits Factor Excursion*	Effective MW Requirement
Winter	Dec. 1 – Feb. 29	HE1 – HE4, HE10 – HE16	HE5 – HE9, HE17 – HE24	HE7 – HE8, HE18 – HE21	Off-Ramp = 525 MW On-Ramp = 800 MW

Requirement	Avg % Reg D Pegged	Avg % of Reg A Pegged
525 MW	27%	44%
800 MW	27%	29%

- No correlation to lower requirement and Reg D pegging
- Some correlation to requirement and Reg A pegging
 - Dispatch will increase requirement based on expected system conditions
 - Example: Jan. 20 HE10-HE16 regulation increase from 525 MW to 800 MW
 - Further analysis to be performed on requirement going forward (quarterly reviews)

Data from 1/9/17 09:00:00 – 1/20/17 00:00:00; Peg = 99% of TREG

- The majority of the time, the Reg D signal is pegged for only small durations of time which is to be expected for ACE control
 - Reg D pegged minimized by system tuning
 - Occasionally pegged longer due to system conditions
 - Long pegs listed below are in full lower direction

Jan.	9	10	11	12	13	14	15	16	17	18	19
20-30min	2	3	0	0	0	1	0	1	0	0	1
>30min	1	0	0	1	0	0	0	0	0	0	0

Data from 1/9/17 09:00:00 – 1/20/17 00:00:00; Peg = 99% of TREG

Regulation Type	MW	Steam	Hydro	CT	Energy Storage	DSR
Reg A	Avg. Performance Score (Jan.1)	75%	86%	84%	NA	85%
	Avg. Performance Score (Jan. 20)	75%	87%	84%	NA	85%
Reg D	Avg. Performance Score (Jan. 1)	NA	77%	90%	96%	85%
	Avg. Performance Score (Jan. 20)	NA	77%	90%	93%	82%

- Continue signal tuning for optimized control
- Analysis on ACE control and resource performance
- MRTS development from operational data
- New regulation test signals scheduled for Jan. 30