



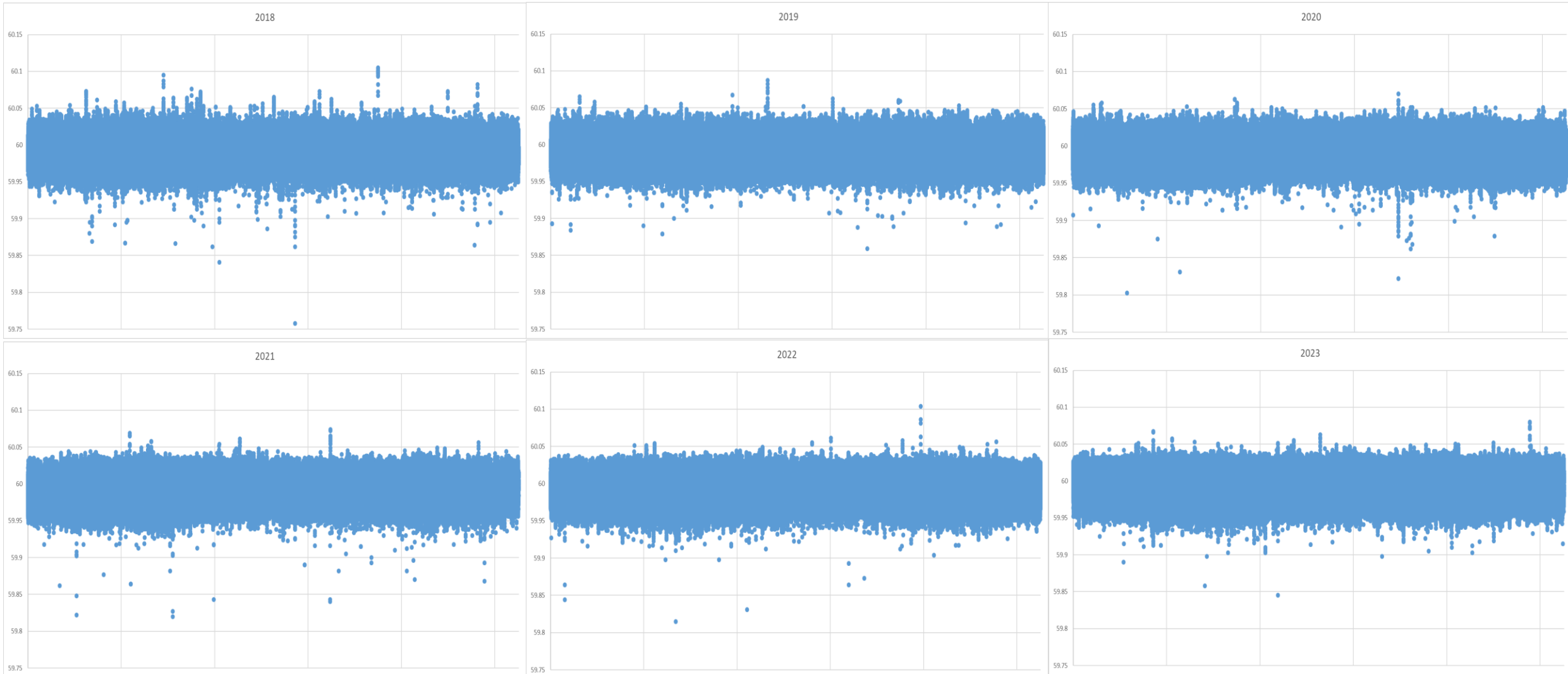
California ISO

Impact of BESS on WECC Frequency Events Does BAL-003 Need to be Revised to Better Account for BESS PFR?

Ali Miremadi

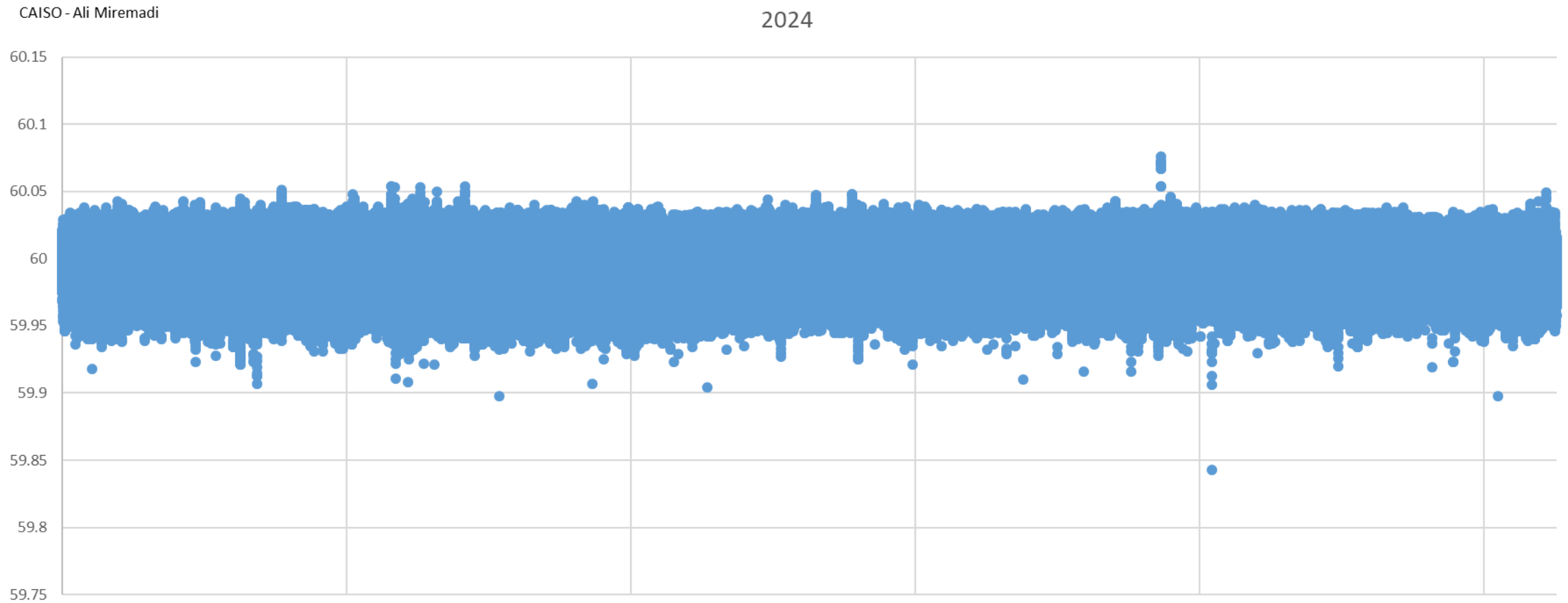
January 2026

Western Interconnection Frequency – 1 Minute (Minimum Value) Data 2018 – 2023



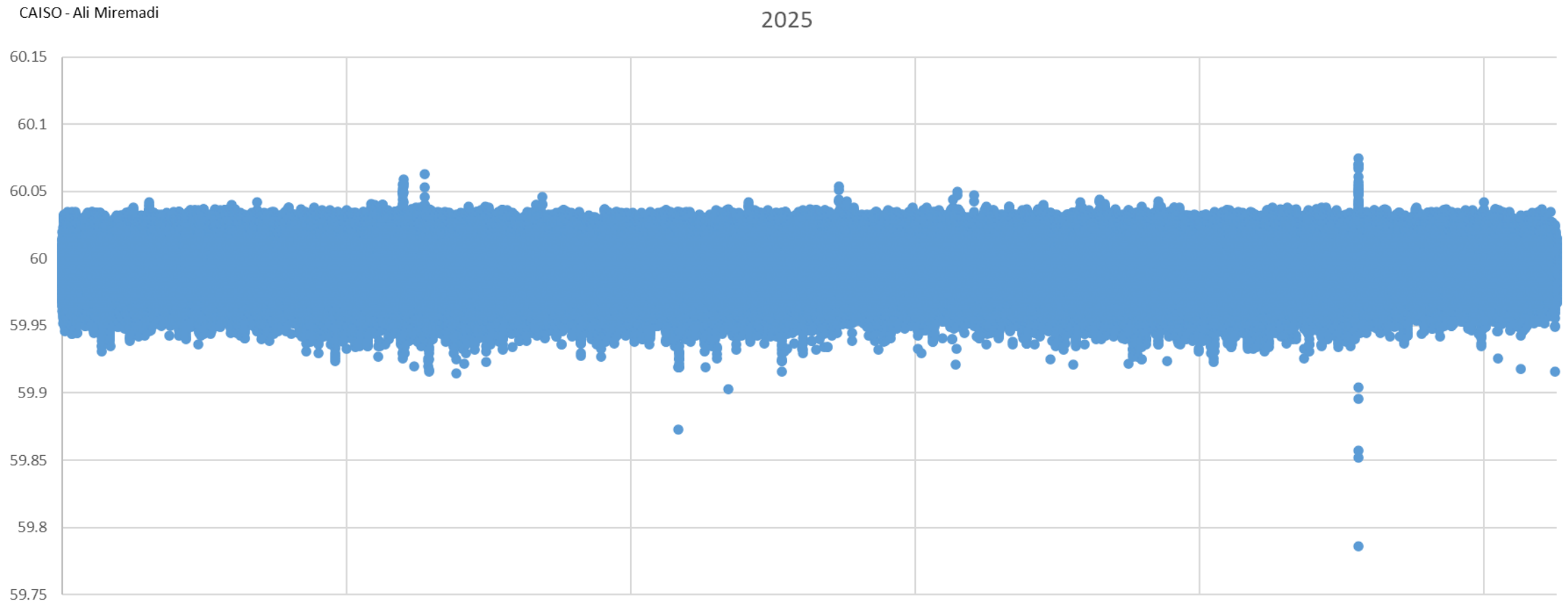
Western Interconnection Frequency – 1 Minute (Minimum Value) Data 2024

Selection Criteria



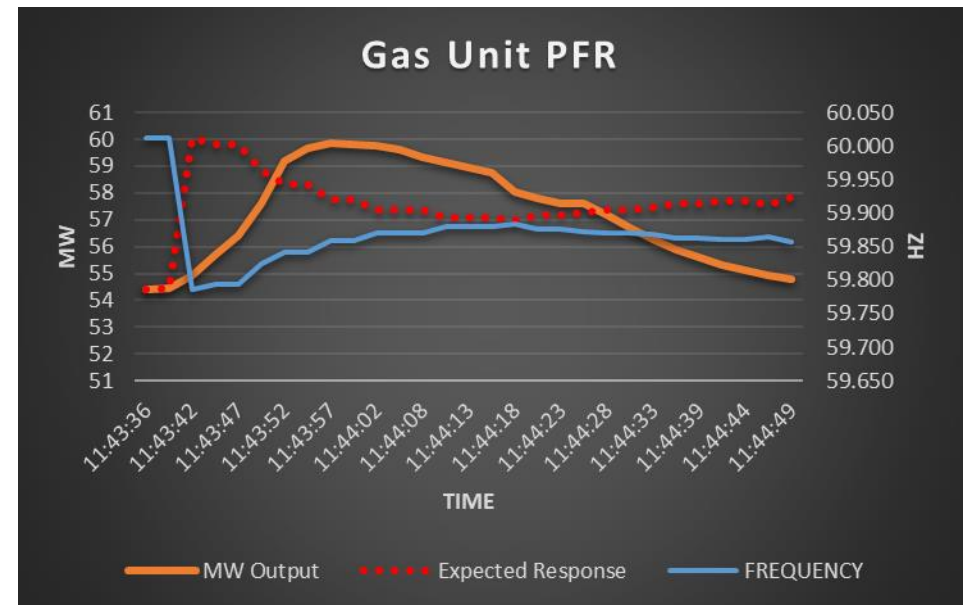
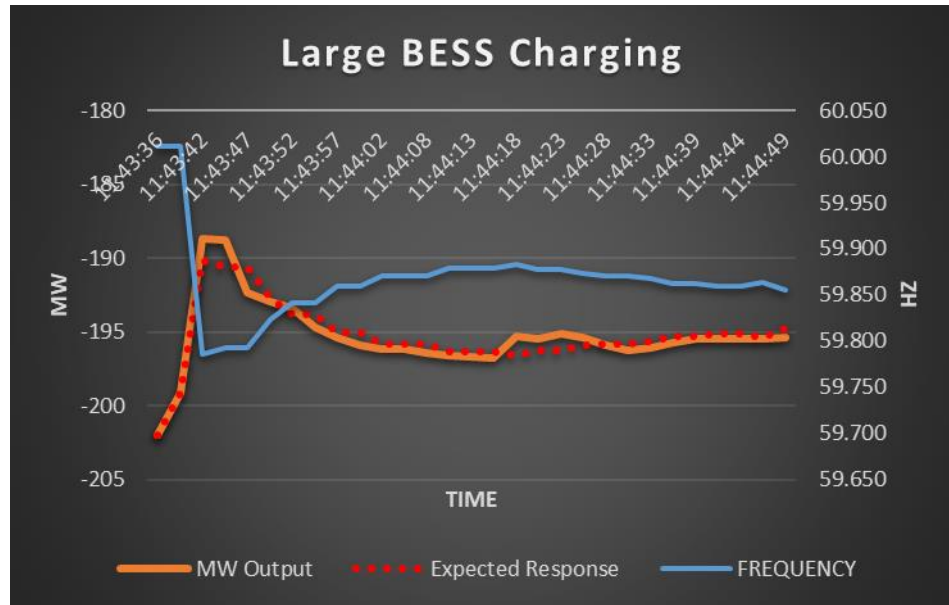
Western Interconnection Frequency – 1 Minute (Minimum Value) Data 2025

Selection Criteria



Compliance Measurement - Actual Examples of Arresting and Recovery PFR

Compliance Measurement



What is the Purpose of BAL-003?

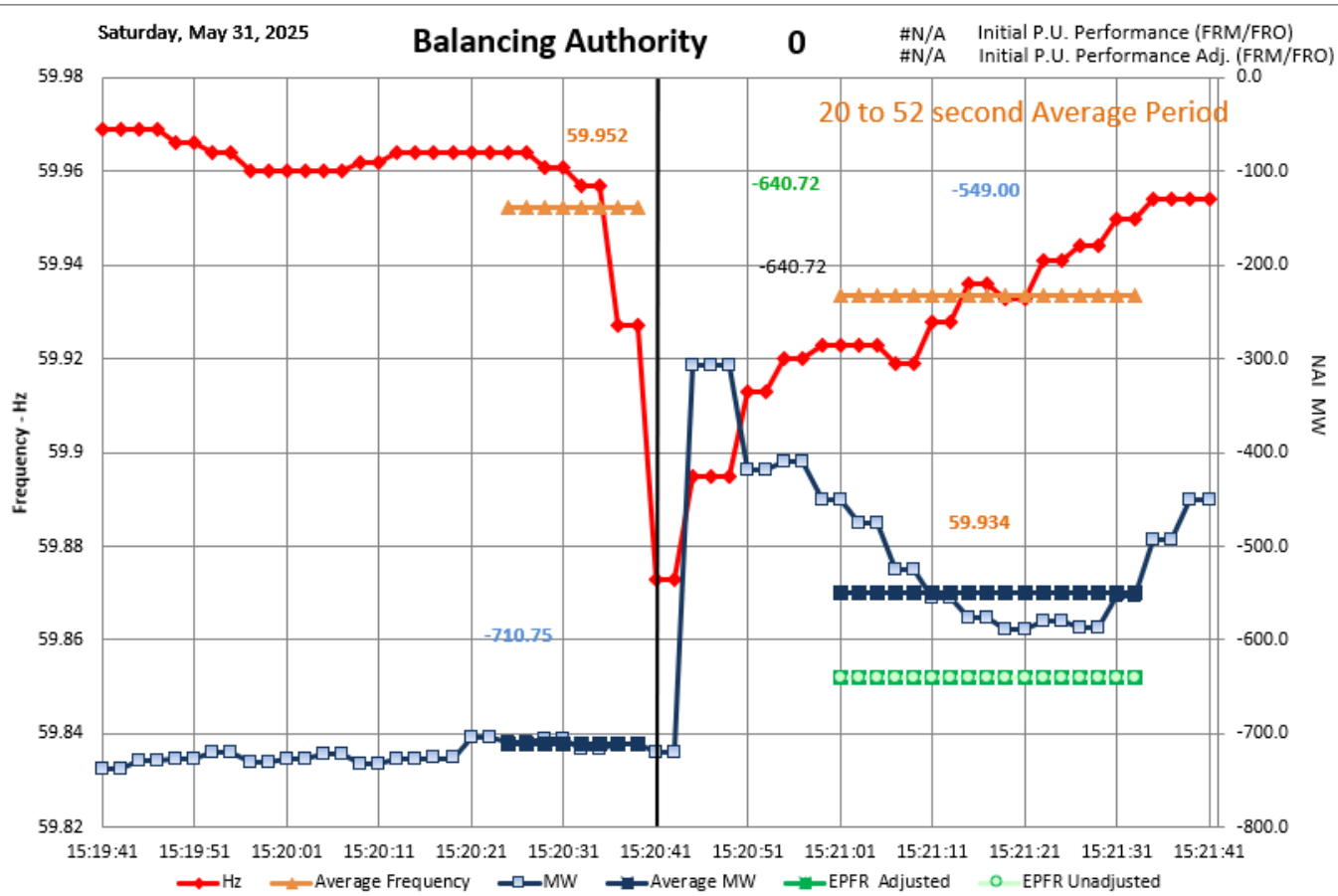
BAL-003 Purpose: To require sufficient Frequency Response from the Balancing Authority (BA) to maintain Interconnection Frequency within predefined bounds by **arresting frequency deviations** and **supporting frequency until the frequency is restored** to its scheduled value. To provide consistent methods for measuring Frequency Response and determining the Frequency Bias Setting.

Two objectives defined by BAL-003 Purpose:

- 1 – Arresting frequency deviations (Arresting PFR)
- 2 – Supporting frequency until frequency is restored (Recovery PFR)

Compliance Measure - Arresting PFR vs. Recovery PFR

Compliance Measurement



	Posted BA 2025 Operating Year FRO (MW/0.1 Hz)
California Independent System Operator	-236.3
Bonneville Power Administration	-82.0
British Columbia Hydro and Power Author	-70.3

Frequency Drop	
Average Freq (-16 - 0) (Hz)	59.952
Average Freq (20-52) (Hz)	59.934
Freq Drop for Compliance Calculation (Hz)	0.018

MW Expected	
FRO (MW/0.1Hz)	-236.30
FRO for 0.018 Hz Drop (MW)	-42.53

FRM Calculation	
Average NAI (-16 - 0) (MW)	-710.75
Average NAI (20-52) (MW)	-549.00
FRM (MW)	-161.75
FRM/FRO	3.80

BAs with IBR are Providing Arresting PFR while BAs with Spinning Mass are Providing Recovery PFR – April 10, 2025

Compliance Measurement

Incremental Change in Net Actual Interchnage

		Arresting PFR (MW)		Recovery PFR (MW)		
		Five BA's With IBR		Eight BA's With Thermal and Hydro		Sum
Seconds from Deadband Having Been Breached	0	164	107	271		
	4	63	122	185		
	8	269	94	363		
	12	233	169	403		
	16	201	134	335		
	20	163	198	361		
	24	111	254	365		
	28	88	305	393		
	32	88	334	422		
	36	50	335	385		
	40	52	330	381		
	44	56	330	385		
	48	36	345	380		
52	67	359	426			
56	52	309	361			

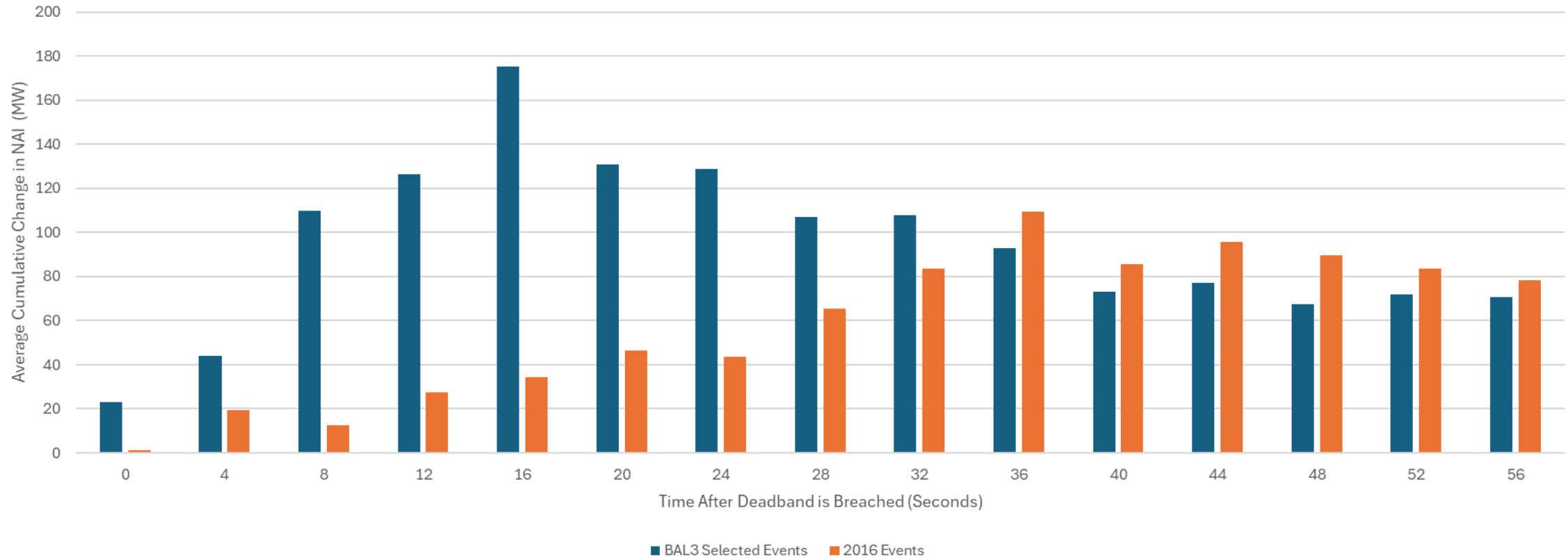
- Conditional formatting applied to visually portray the high (green) and low (red) range for each column.
- For April 10th, 2025, four of the five BAs with IBR failed the compliance measure, while all eight BAs with Thermal and Hydro passed the compliance measure.

CAISO PFR Response Has Shifted from Recovery to Arresting Due to IBR

Compliance Measurement

CAISO - Ali Mirejadi

Comparing CAISO Response Profile between BAL-003 Selected Events and 2016 Events



Conclusions

- Western Interconnection frequency nadir has moved up - impacting number of events qualified for BAL-003 compliance
- BESS provides fast/accurate/timely PFR – arresting PFR
- BAL-003 only measures recovery PFR, even though measuring arresting PFR is stated in “Purpose” section of standard
- Balancing Authorities with BESS are negatively impacted by BAL-003 compliance accounting
- NERC Project 2017-01 is ongoing and it is reviewing BAL-003