



Changes in Interconnection Frequency Control (Ramping)

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Greg Park—WECC, Manager
Risk Analysis and Data Services

NERC RS Chair

Essential Reliability Services

- <https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/ERS%20Abstract%20Report%20Final.pdf>
- <https://vimeopro.com/nerclearning/erstf-1>

Essential Reliability Services

Voltage—Voltage must be controlled to protect system reliability and move power where it is needed in both normal operations and following a disturbance. Voltage issues tend to be local in nature, such as in sub-areas of the transmission and distribution systems. Reactive power is needed to keep electricity flowing and maintain necessary voltage levels.

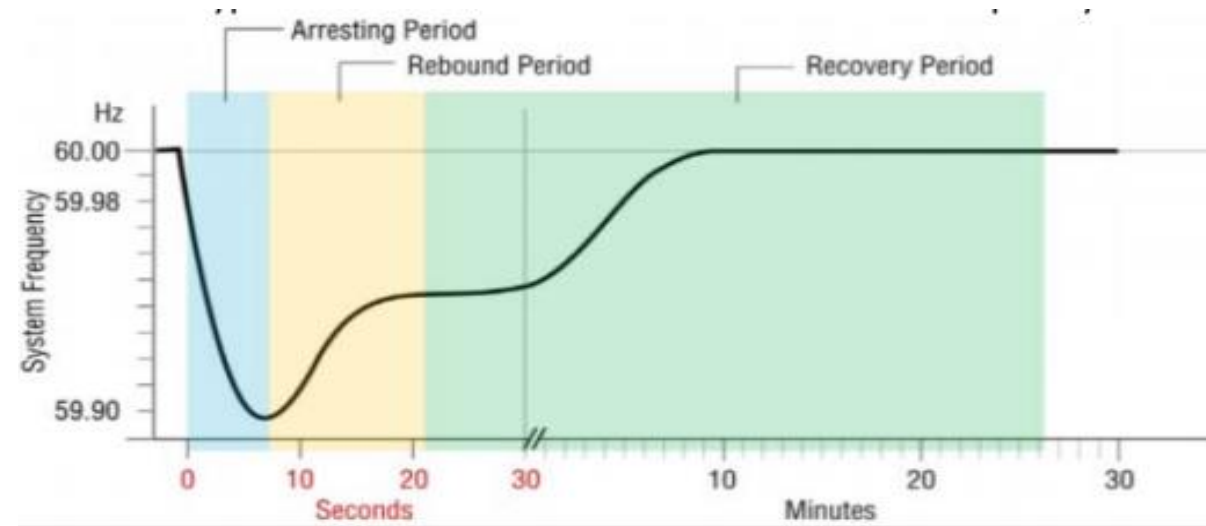
Essential Reliability Services

Frequency—

Grid designed to operate at 60 hertz (Hz).

Deviations can destroy generators, motors, and equipment

Restoring frequency after a disturbance like loss of generation is critical.



Arresting period: requires instantaneous (inertial) response from some resources, and fast response from others

Rebound period: requires fast increase in power to stabilize the frequency,

Recovery period: requires prolonged contribution of power to compensate for lost resources and bring frequency to normal.

Essential Reliability Services

Ramping—Adequate ramping capability (the ability to match load and generation at all times) is necessary to maintain system frequency. Changes to the generation mix or the system operator's ability to adjust resource output can affect the ability of the operator to keep the system in balance.

Multi BA—Interconnections

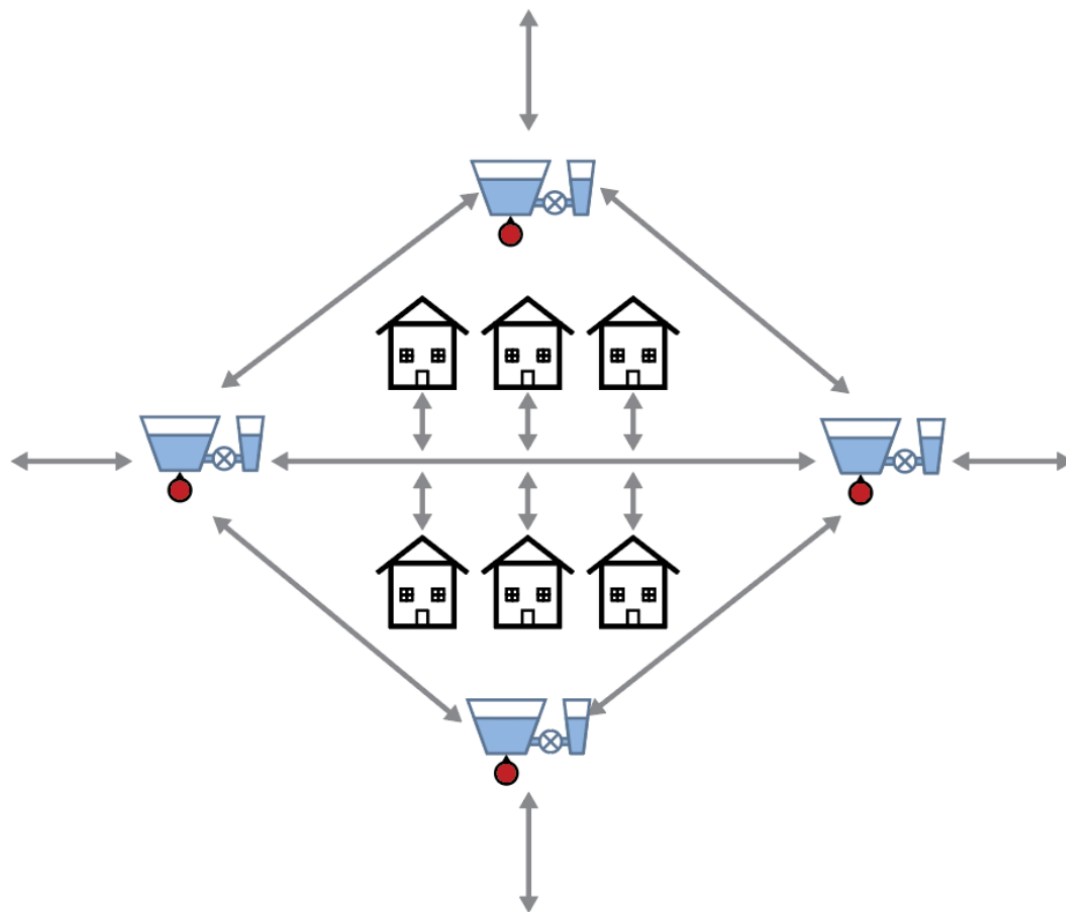
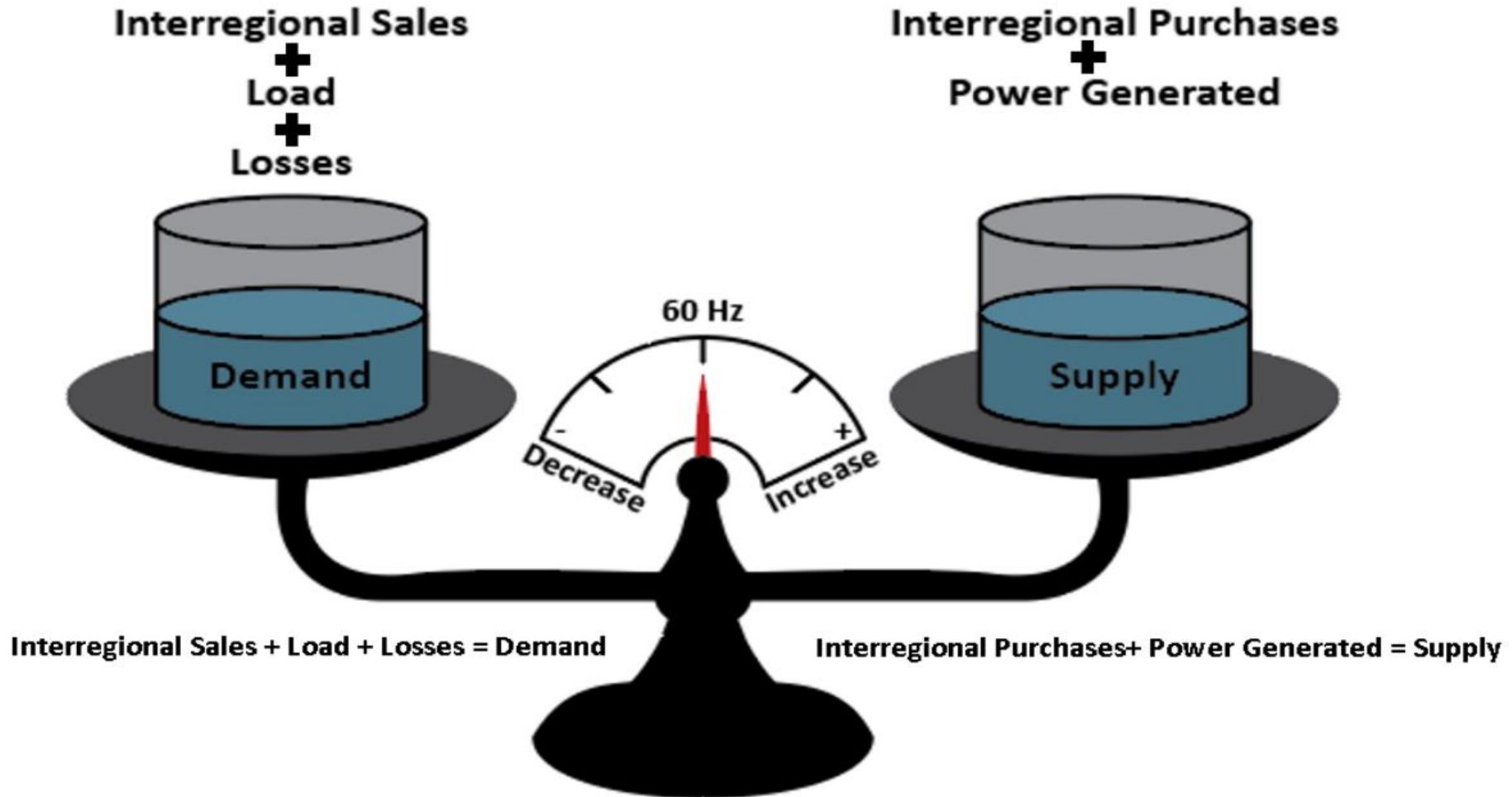


Figure 1:5: BA Analogy

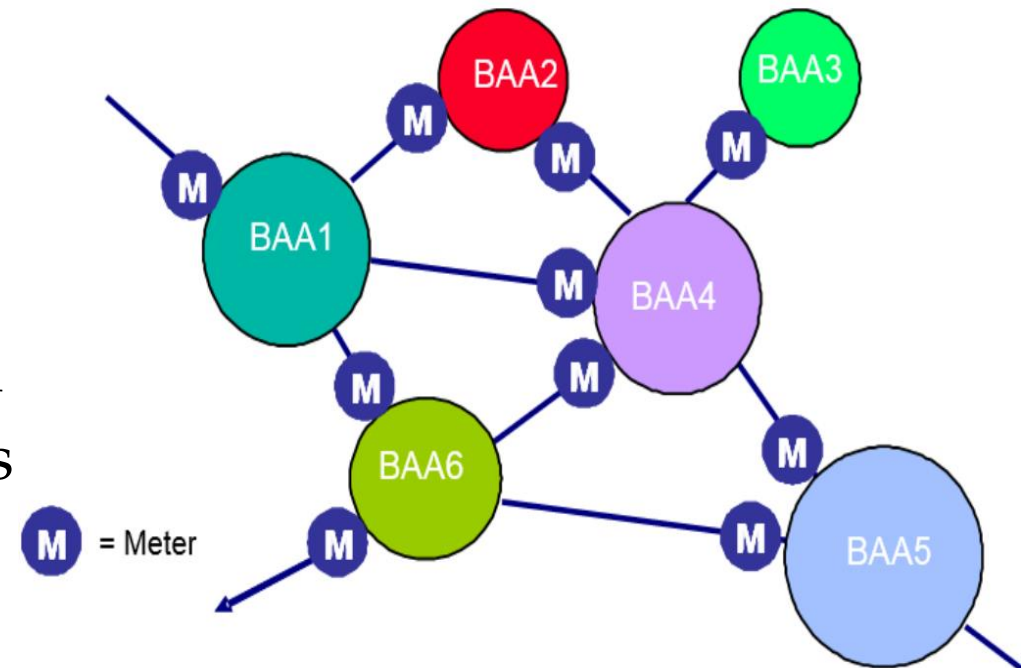
What is Frequency Control?



Multi BA—Interconnections

There are two inputs to the BAs control process:

- Interchange Error: net outflow or inflow compared to the scheduled sales or purchases (The units of interchange error are in megawatts.)
- Frequency Error: the difference between actual and nominal frequency (The units of frequency error are hertz.)



BA Control Fundamentals

- BAL-001 dictates the limits that apply to control of frequency over longer durations. Compliance limits are 30 minutes and a rolling 12-month average (BAAL and CPS1).
- BAL-002 dictates the limits that apply to control frequency over intermediate durations that generally occur due to unplanned losses of resources. Compliance limits are 15 minutes (RBCE Recovery “DCS”).
- BAL-003 dictate the limits that apply to control frequency during short durations. Compliance limits are measured at 20-52 seconds after an event occurs (Frequency Response Measure—FRM).

BA Control Fundamentals

- Demand and supply are constantly changing within all BAAs. This means that a BA will usually have some unintentional outflow or inflow at any given instant. This mismatch in meeting a BA's internal obligations, along with the small additional "bias" obligation to maintain frequency, is represented by a real-time value called Reporting Area Control Error (ACE), with units in MW.
- Frequency bias (β) is used to translate the frequency error into megawatts. β is the BA's obligation to provide or absorb energy to help maintain frequency. In other words, if frequency goes low, each BA is asked to contribute a small amount of extra generation in proportion to its system's size.

Reporting ACE

$$\text{Reporting ACE} = (\text{NI}_A - \text{NI}_S) - 10B (F_A - F_S) - I_{ME} + \textcolor{red}{I_{IM}}$$

Where:

- NI_A = Actual Net Interchange.
- NI_S = Scheduled Net Interchange.
- B = Frequency Bias Setting.
- F_A = Actual Frequency.
- F_S = Scheduled Frequency.
- I_{ME} = Interchange Meter Error.
- $\textcolor{red}{I_{IM}}$ = **Inadvertent Interchange Management**. (Term is expressed if a regional procedure exists, otherwise is null and is not included in the Balancing Authority's Reporting ACE.)
 - In the Western Interconnection this term is I_{ATEC}

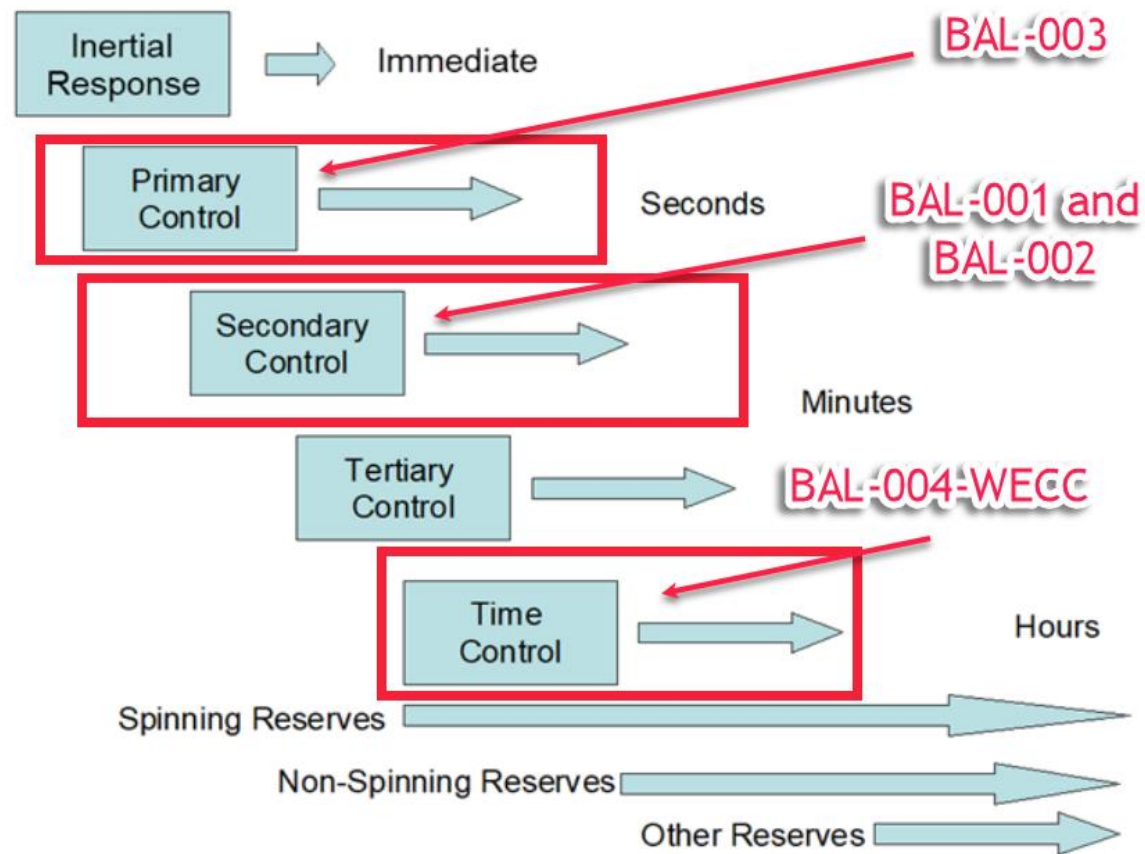
Frequency
Error

Interchange Error

BA Control Fundamentals—BAL-001 and BAL-002

- BAs fulfill their NERC obligations by monitoring Reporting ACE and keeping the value within limits that are generally proportional to BA size. This balancing is typically accomplished through a combination of adjustments of supply resources, purchases and sales of electricity with other BAs, and possibly adjustments of demand.
- Reporting ACE is to a BA what frequency is to the interconnection.
- Over-generation makes Reporting ACE go positive and puts upward pressure on interconnection frequency.
- A large negative Reporting ACE can cause interconnection frequency to drop.
- A highly variable or “noisy” Reporting ACE tends to contribute to similarly “noisy” frequency.

BA Control Continuum



BA Control Continuum

Table 1.1: Control Continuum Summary

Control	Ancillary Service/ERS	Timeframe	NERC Measurement
Inertial Control	Inertial Control	0–12 Seconds	N/A
Primary Control	Frequency Response	10–60 Seconds	FRM
Secondary Control	Regulation	1–10 Minutes	CPS1 – DCS - BAAL
Tertiary Control	Imbalance/Reserves	10 Minutes–Hours	BAAL - DCS
Time Control	Time Error Correction	Hours	N/A

Problem Statement

- With the increase of non-dispatchable variable energy resources, the ability to control frequency has become much more difficult during periods of large solar ramps both morning and late afternoon.
- Many BAs are experiencing an increasingly difficult time meeting the regulation requirements of BAL-001 while not having a significant change to their resource mix.
- Review of Western Interconnection Hz data indicated that certain hours of certain months, the average Hz was outside of prescribed governor deadbands (.036 mHz) for the entire hour.

Problem Statement

- Traditional metrics of monitoring interconnection frequency performance did **NOT** indicate any significant changes in year-over-year regulation control issues
 - Daily average frequency
 - Frequency RMS (Noise of normal random movement of frequency)
 - M6 metric (three-hour ramping by BA)

What is “CPS1”

- CPS1 is the metric defined in BAL-001 which sets the compliance limit for every BA
- CPS1 is calculated every minute through comparison of a BA's Reporting ACE to any deviation from scheduled frequency.
- If ACE is positive and frequency is above nominal, a BA will receive a low score (less than 100%)
- If ACE is negative and frequency is below nominal, a BA will receive a low score (less than 100%)
- If ACE is positive and frequency is below nominal, a BA will receive a high score (greater than 100%)
- If ACE is negative and frequency is above nominal, a BA will receive a high score (greater than 100%)

What is “BAAL”

BAAL is mathematically equivalent to a “One-Minute” CPS1 Score more negative than -700%

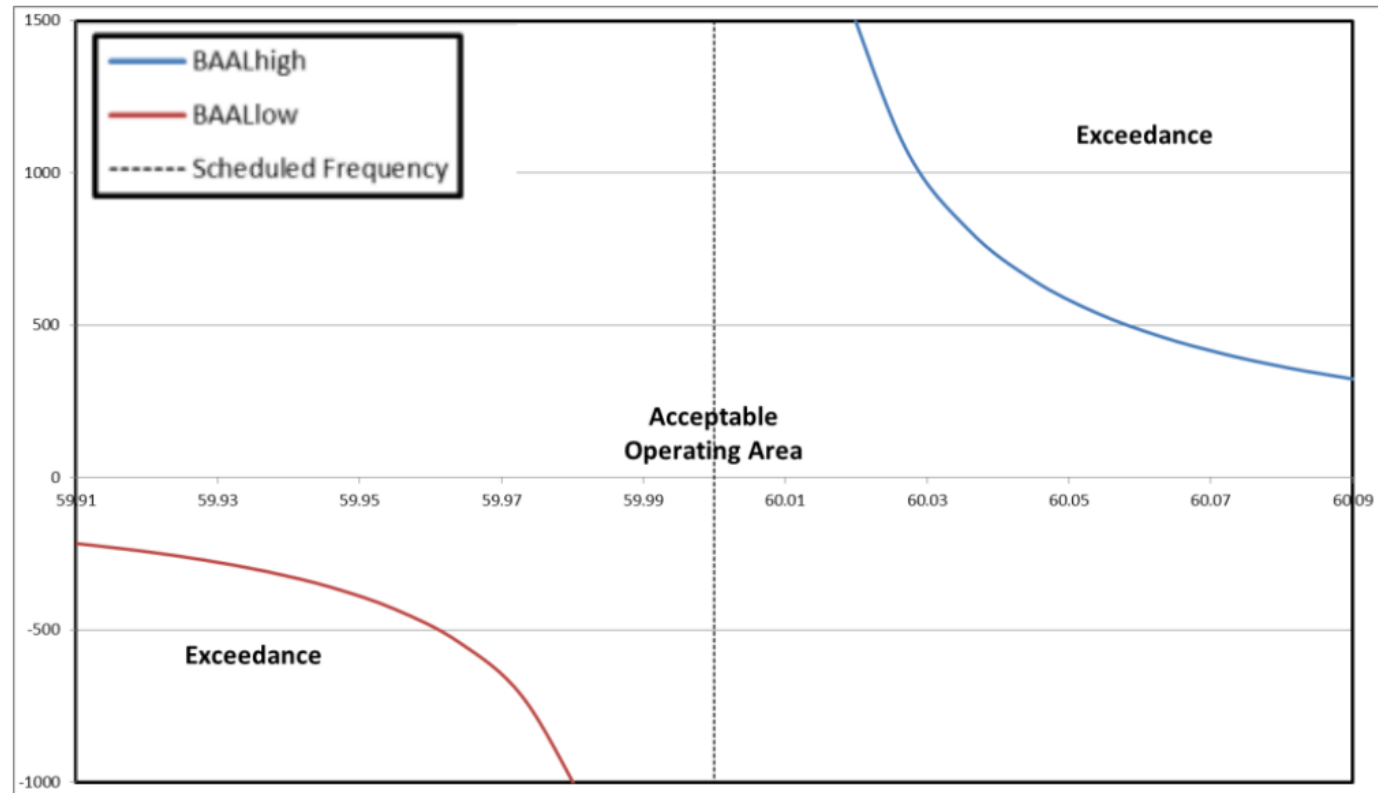
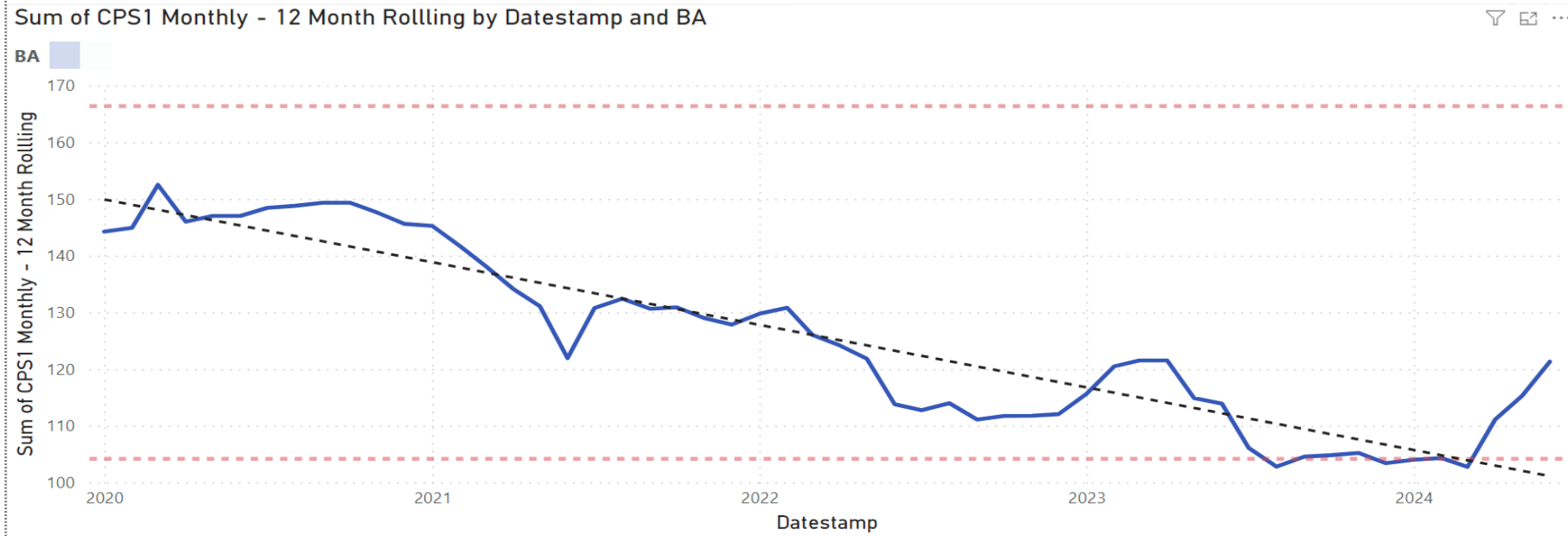
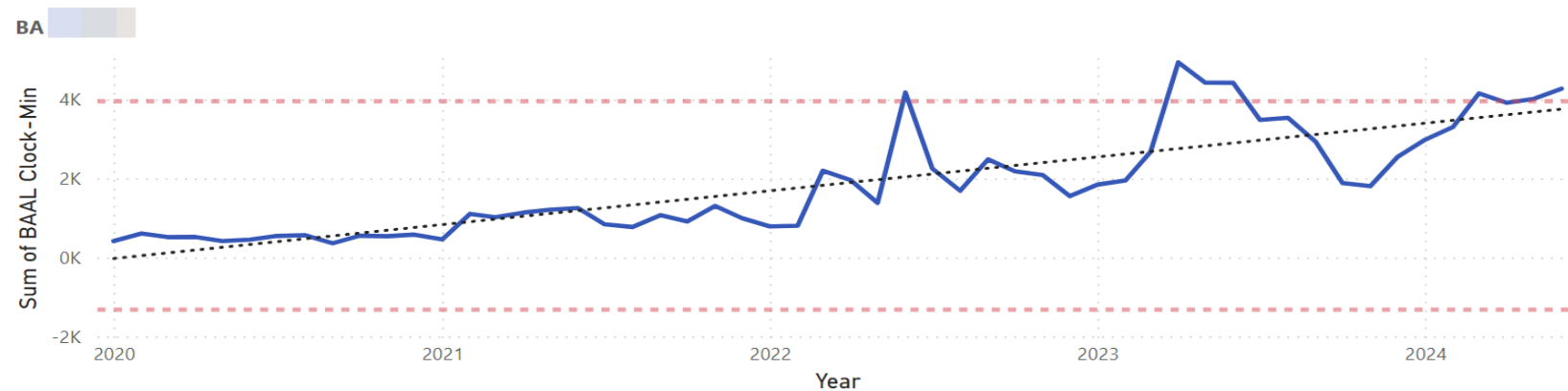


Figure 3.4: Acceptable Operating Area and the **BAAL** limit exceedance area

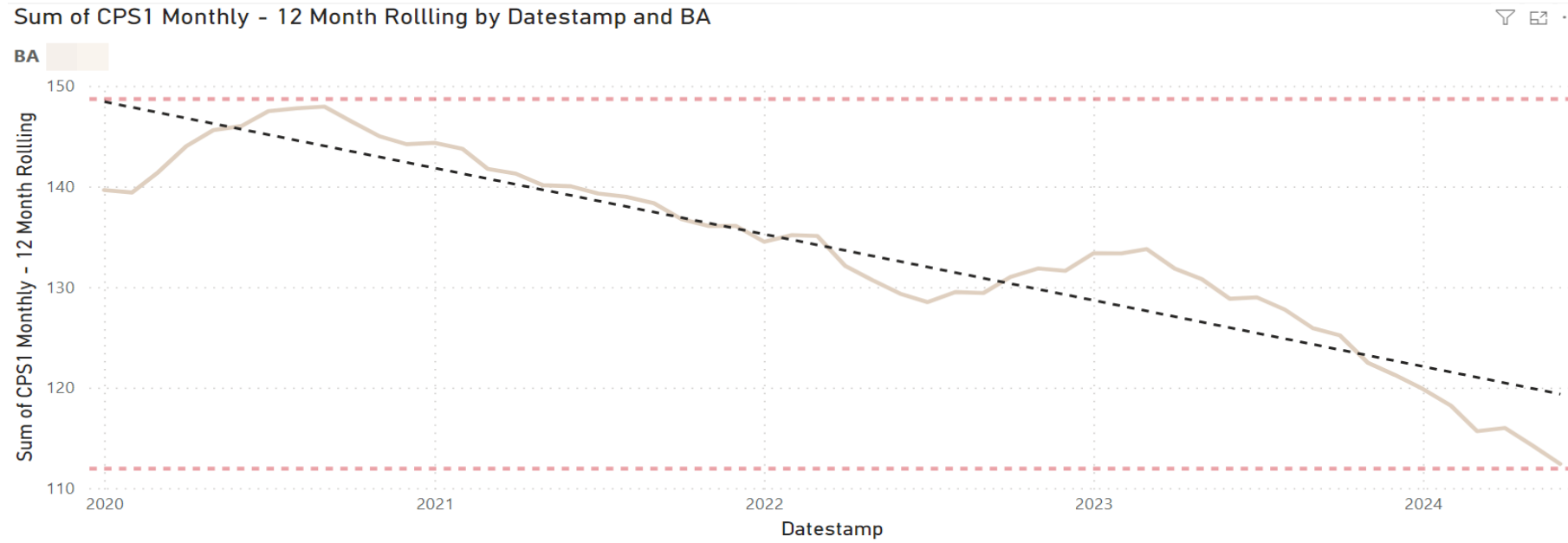
Examples of BA's Struggles



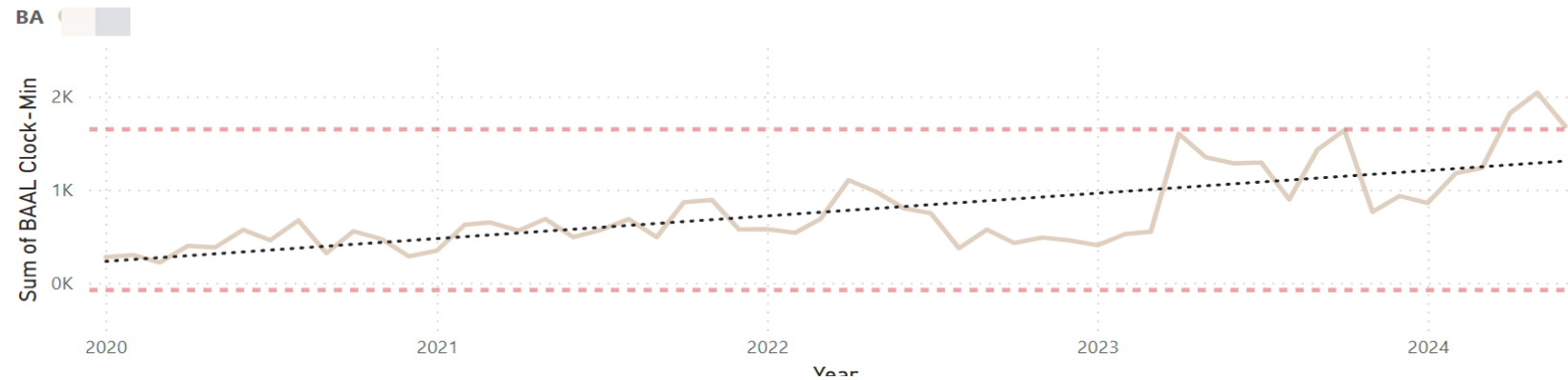
Sum of BAAL Clock-Min by Year, Month and BA



Examples of BA's Struggles

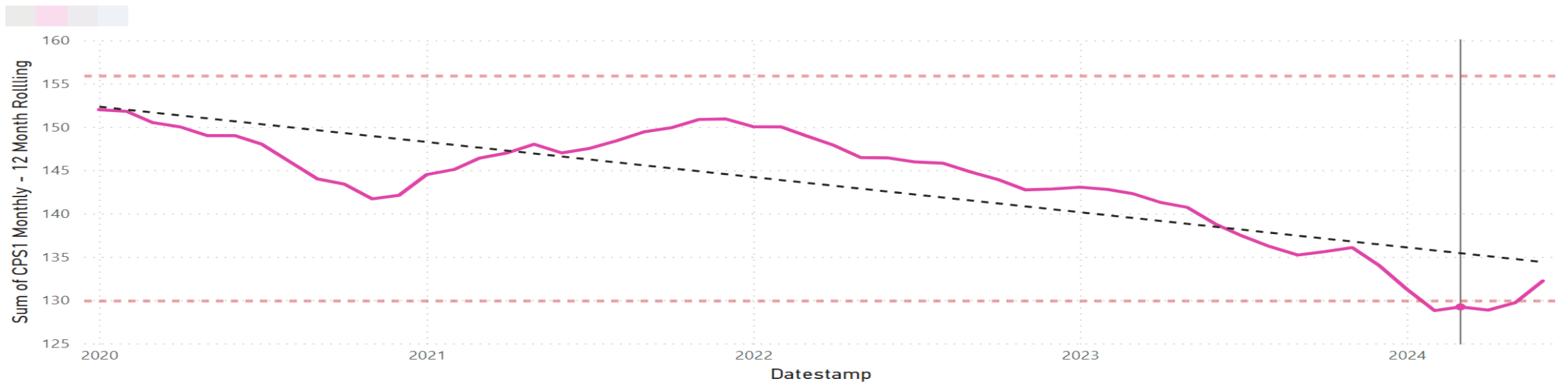


Sum of BAAL Clock-Min by Year, Month and BA

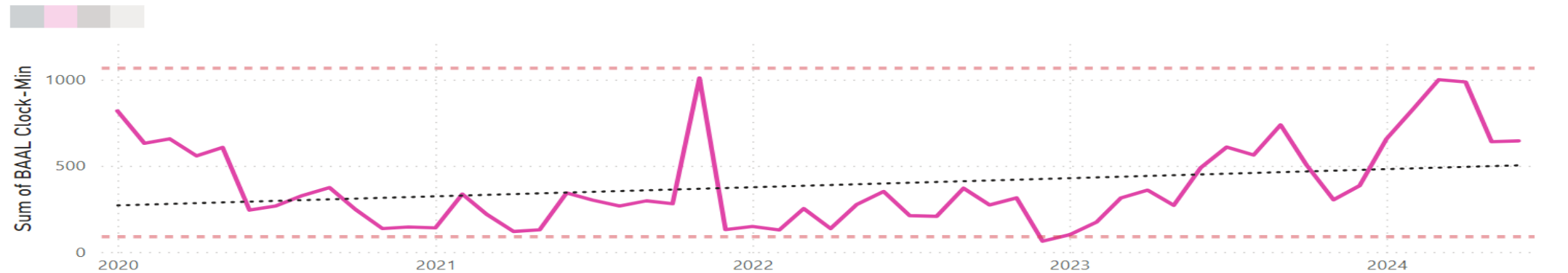


Examples of BA's Struggles

Sum of CPS1 Monthly - 12 Month Rolling by Datestamp and BA

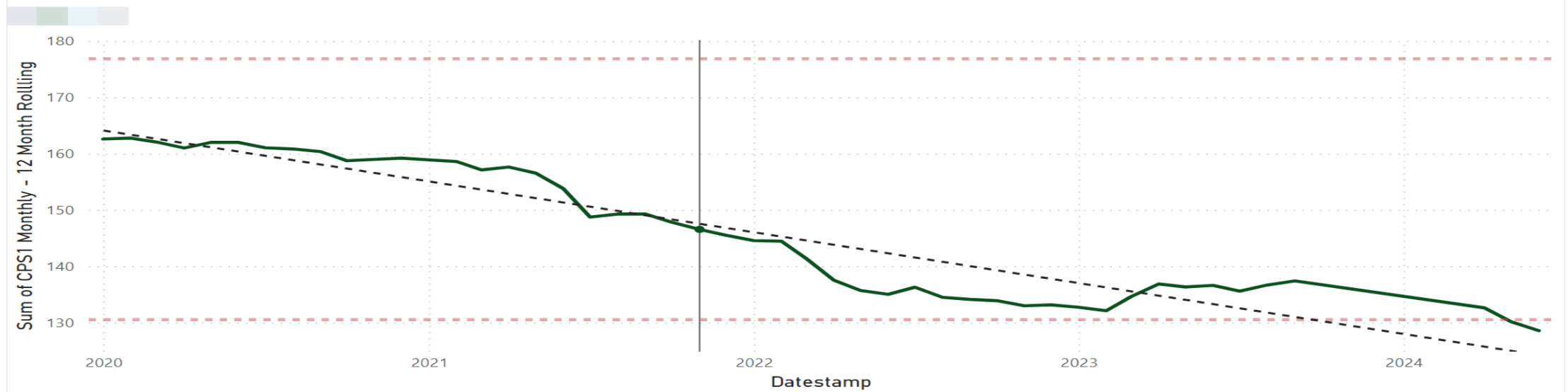


Sum of BAAL Clock-Min by Year, Month and BA

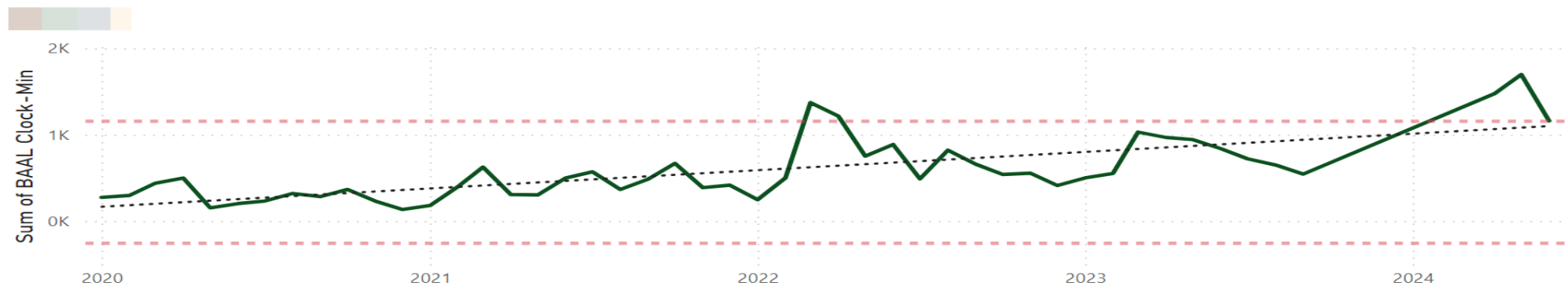


Examples of BA's Struggles

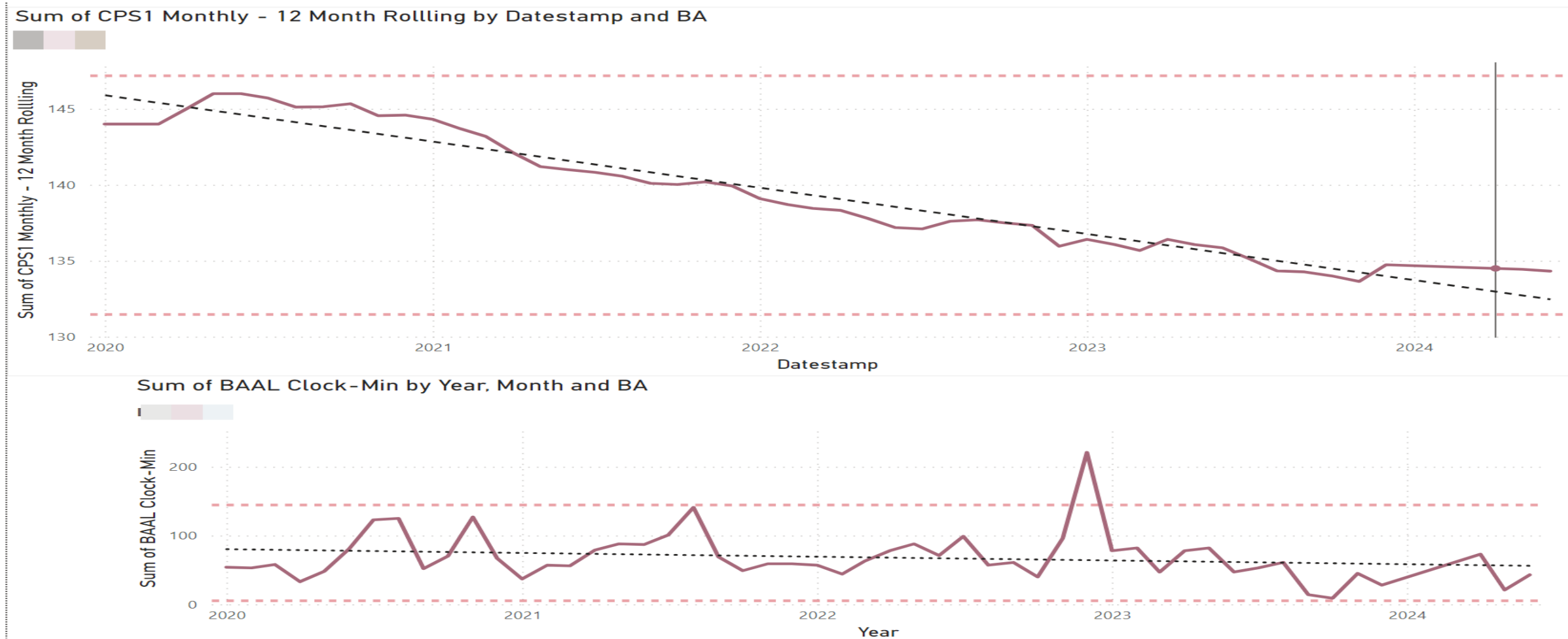
Sum of CPS1 Monthly - 12 Month Rolling by Datestamp and BA



Sum of BAAL Clock-Min by Year, Month and BA

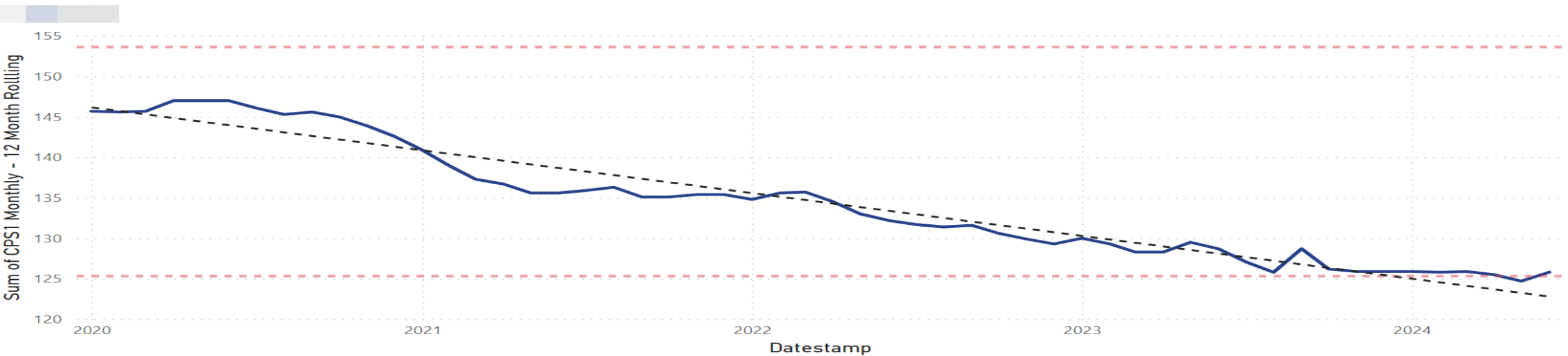


Examples of BA's Struggles

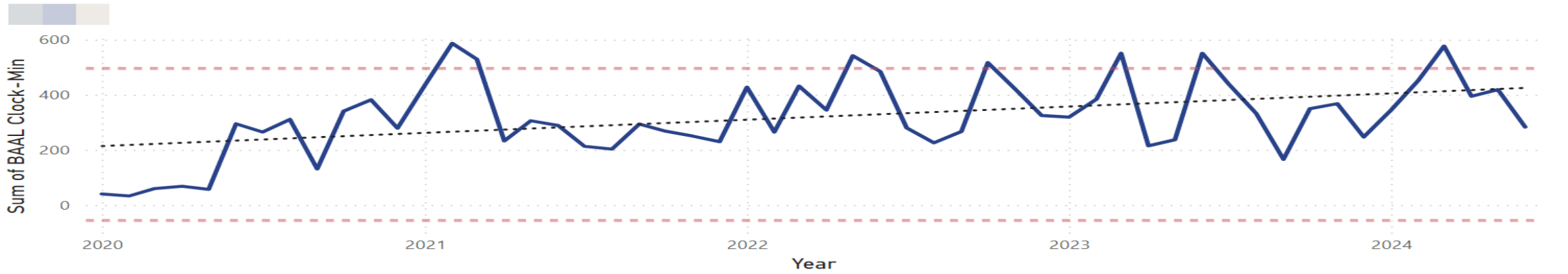


Examples of BA's Struggles

Sum of CPS1 Monthly - 12 Month Rollling by Datestamp and BA

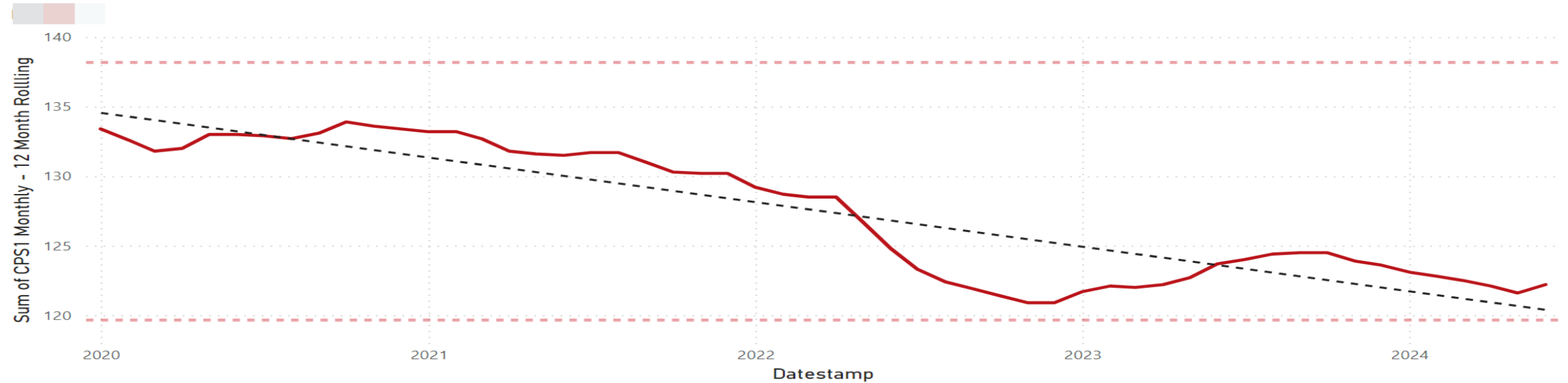


Sum of BAAL Clock-Min by Year, Month and BA

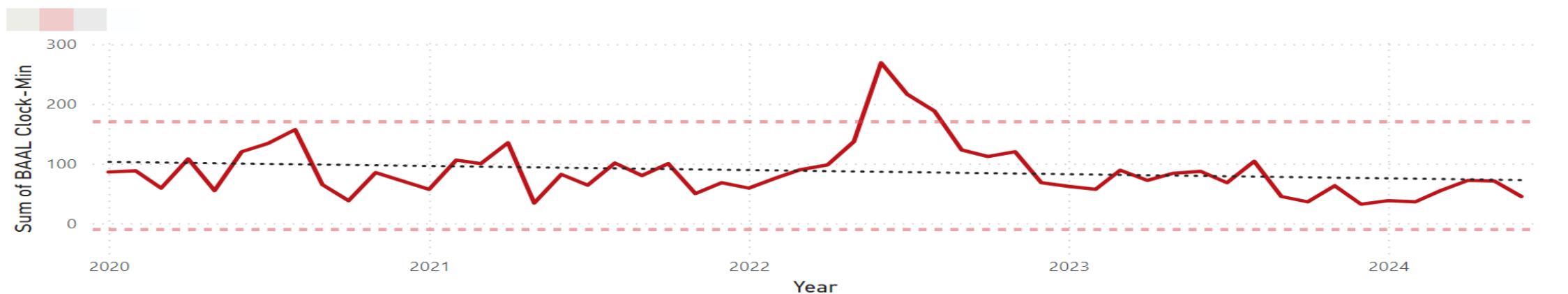


Examples of BA's Struggles

Sum of CPS1 Monthly - 12 Month Rolling by Datestamp and BA

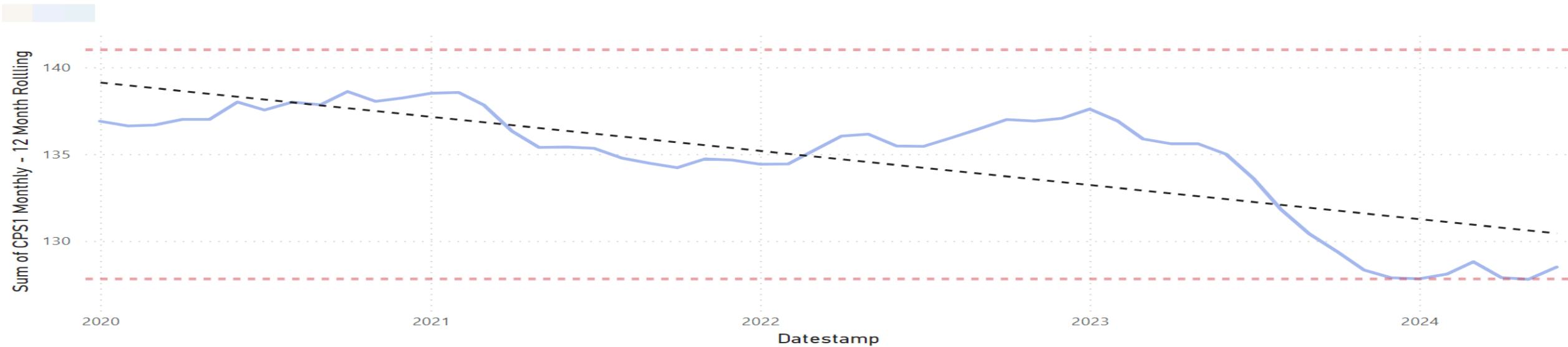


Sum of BAAL Clock-Min by Year, Month and BA

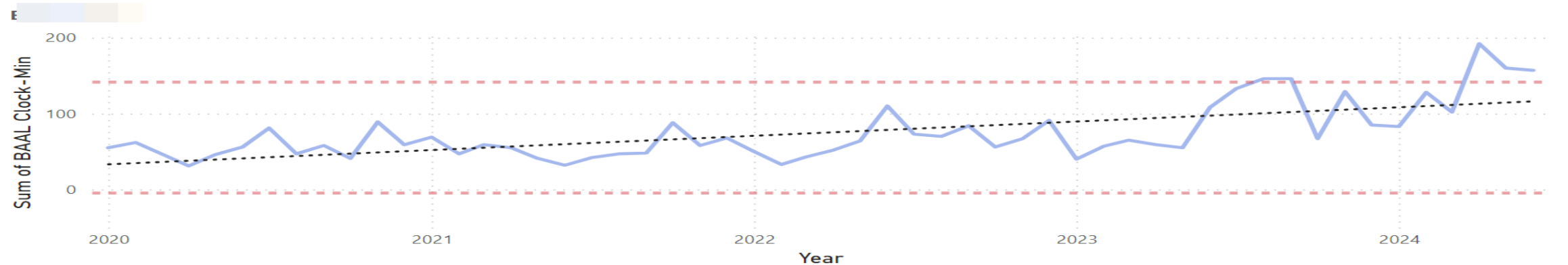


Examples of BA's Struggles

Sum of CPS1 Monthly - 12 Month Rolling by Datestamp and BA



Sum of BAAL Clock-Min by Year, Month and BA



Solution

- The NERC RS wanted to develop a method to determine whether frequency control was becoming more difficult from year to year and whether the control was affected by the integration of photovoltaic resources.
- The metric that BAs use to determine how “well” they perform their regulation responsibilities is “CPS1”
- Which led to the next question: Can CPS1 be calculated on the interconnection level?

CPS1—Show me the math

$$\text{CPS1} = (2 - CF) * 100\%$$

$$CF = \frac{CF_{12\text{-month}}}{(\epsilon_{1l})^2}$$

$$CF_{\text{clock-minute}} = \left[\left(\frac{RACE}{-10B} \right)_{\text{clock-minute}} * \Delta F_{\text{clock-minute}} \right]$$

CPS1 Interconnection—Show me the math

Expand ACE:

$$CF = \frac{(NAI - NSI) - 10\beta(\Delta F) * \Delta F}{-10\beta * \varepsilon_1^2}$$

Assume NAI-NSI = 0 for interconnection level:

$$CF = \frac{(0) - 10\beta(\Delta F) * \Delta F}{-10\beta * \varepsilon_1^2}$$

CPS1_{Interconnection}—Show me the math

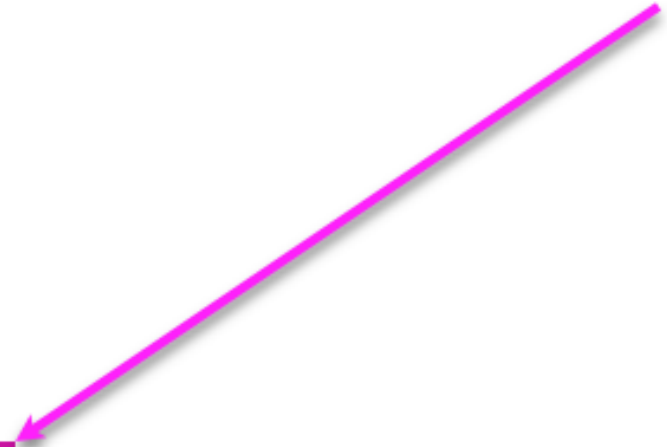
Cancel and simplify:

$$CF = \frac{\Delta F^2}{\varepsilon_1^2}$$

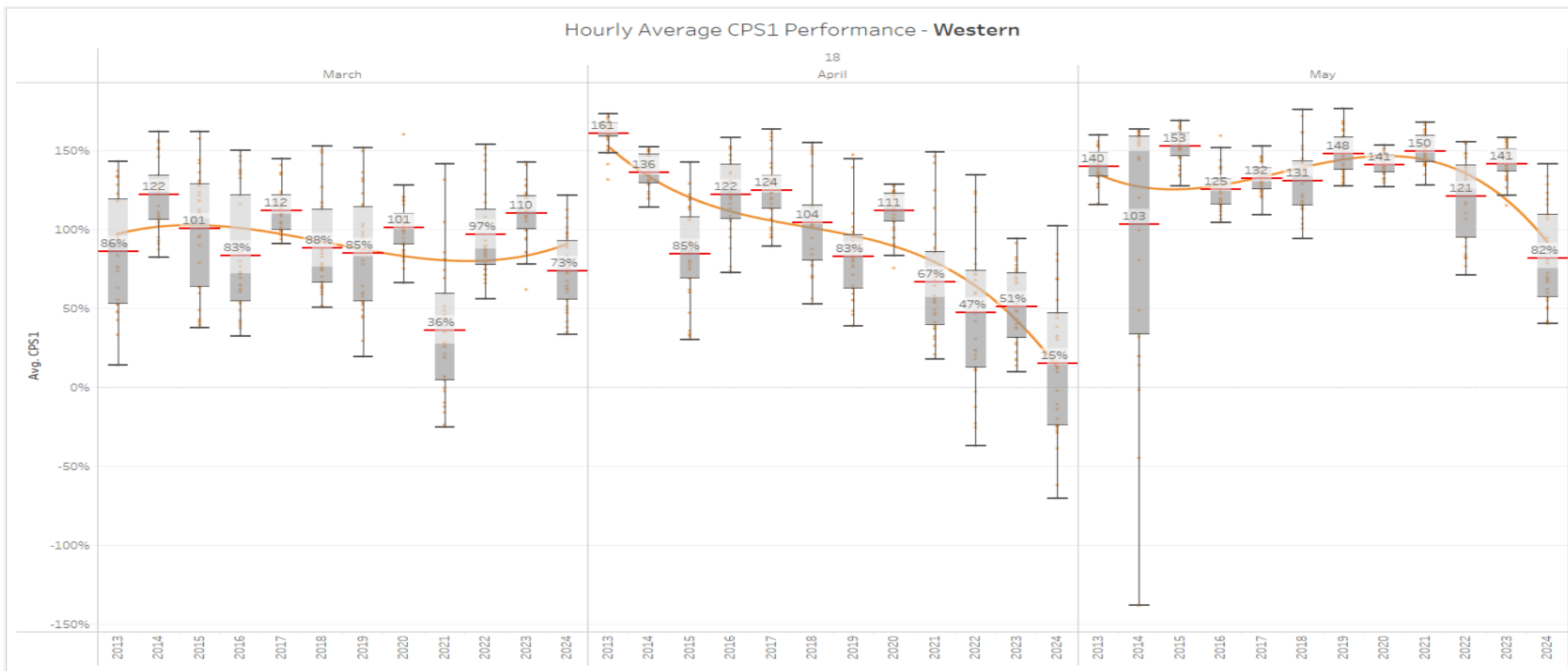
$$CPS1_{Interconnection} = 100 * \left(2 - \frac{\Delta F^2}{\varepsilon_1^2} \right)$$

CPS1_{Interconnection}—Show me the math

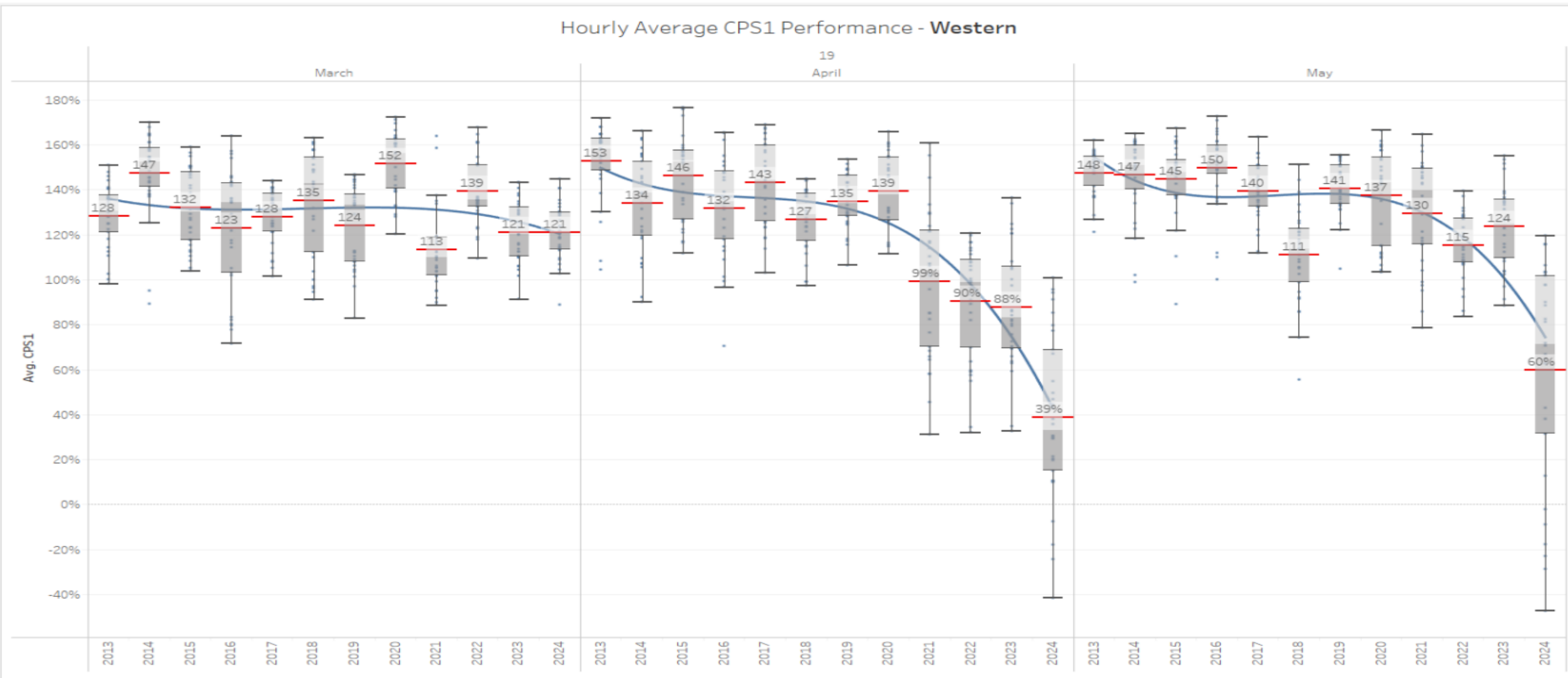
This is the only remaining Variable. Epsilon is a "variable" that hasn't changed in decades

$$CPS1_{Interconnection} = 100 * \left(2 - \frac{\Delta F^2}{\epsilon_1^2} \right)$$


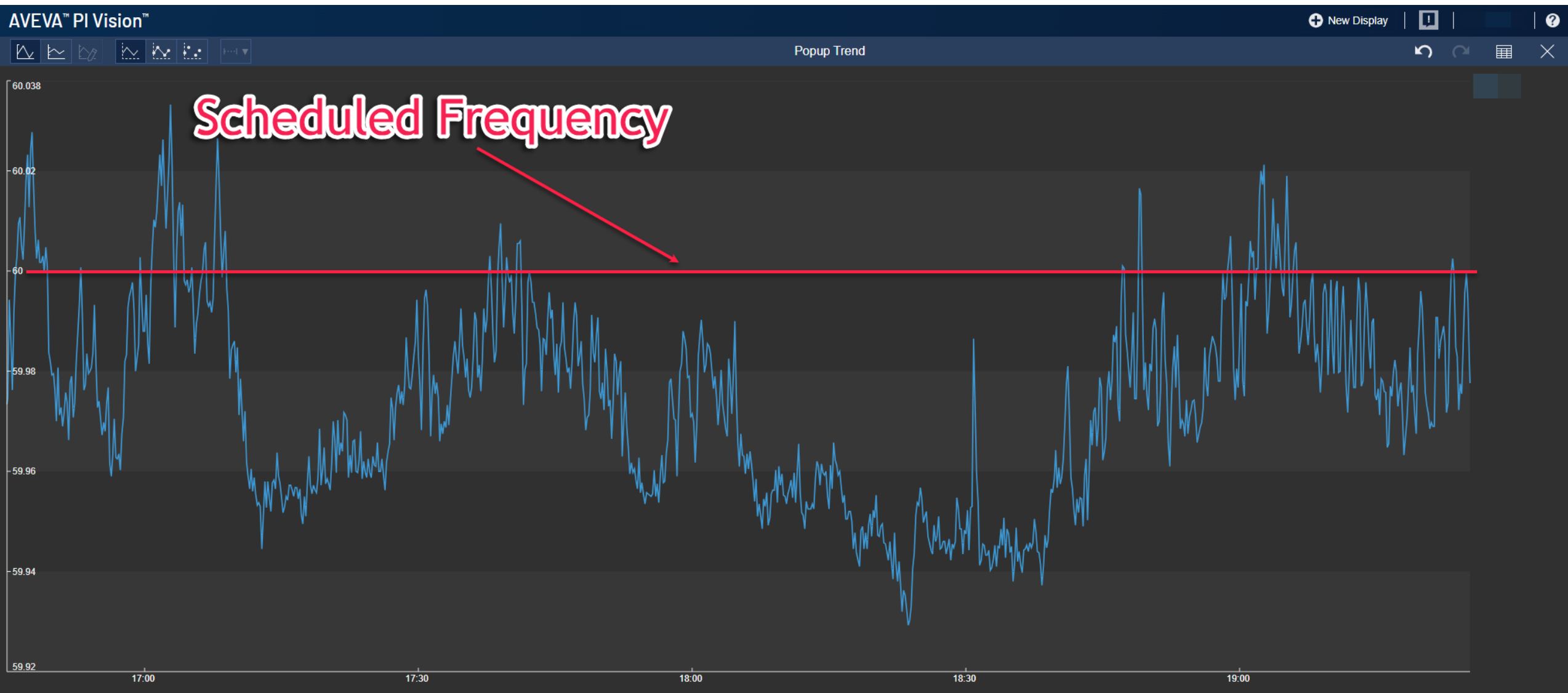
Hour Ending 1800



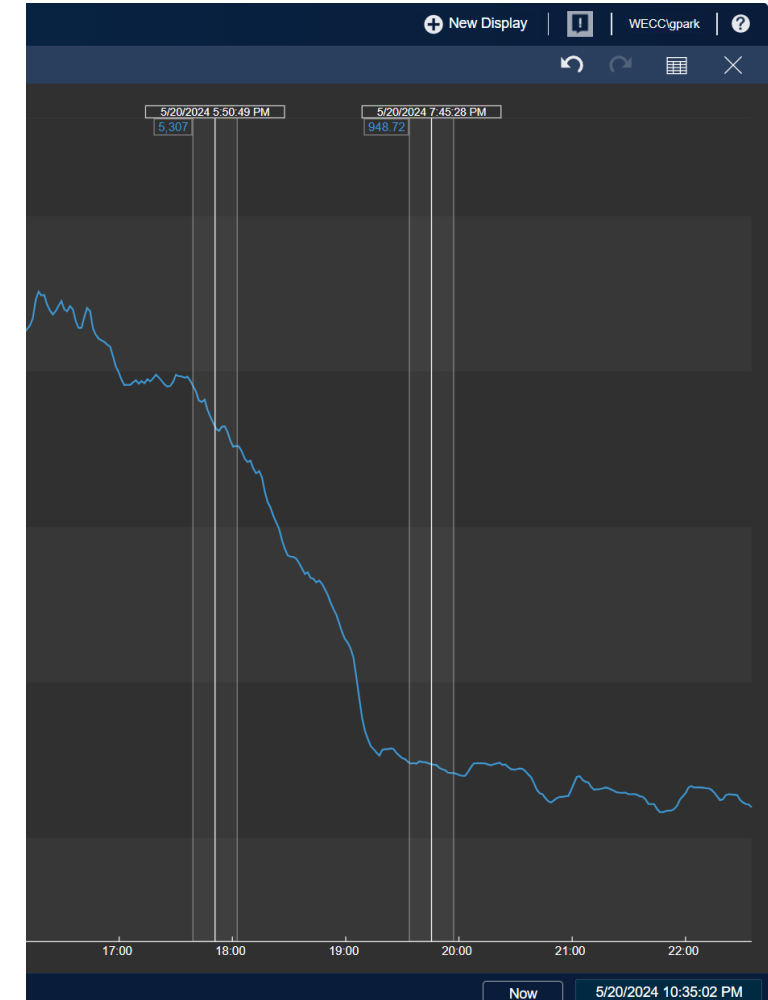
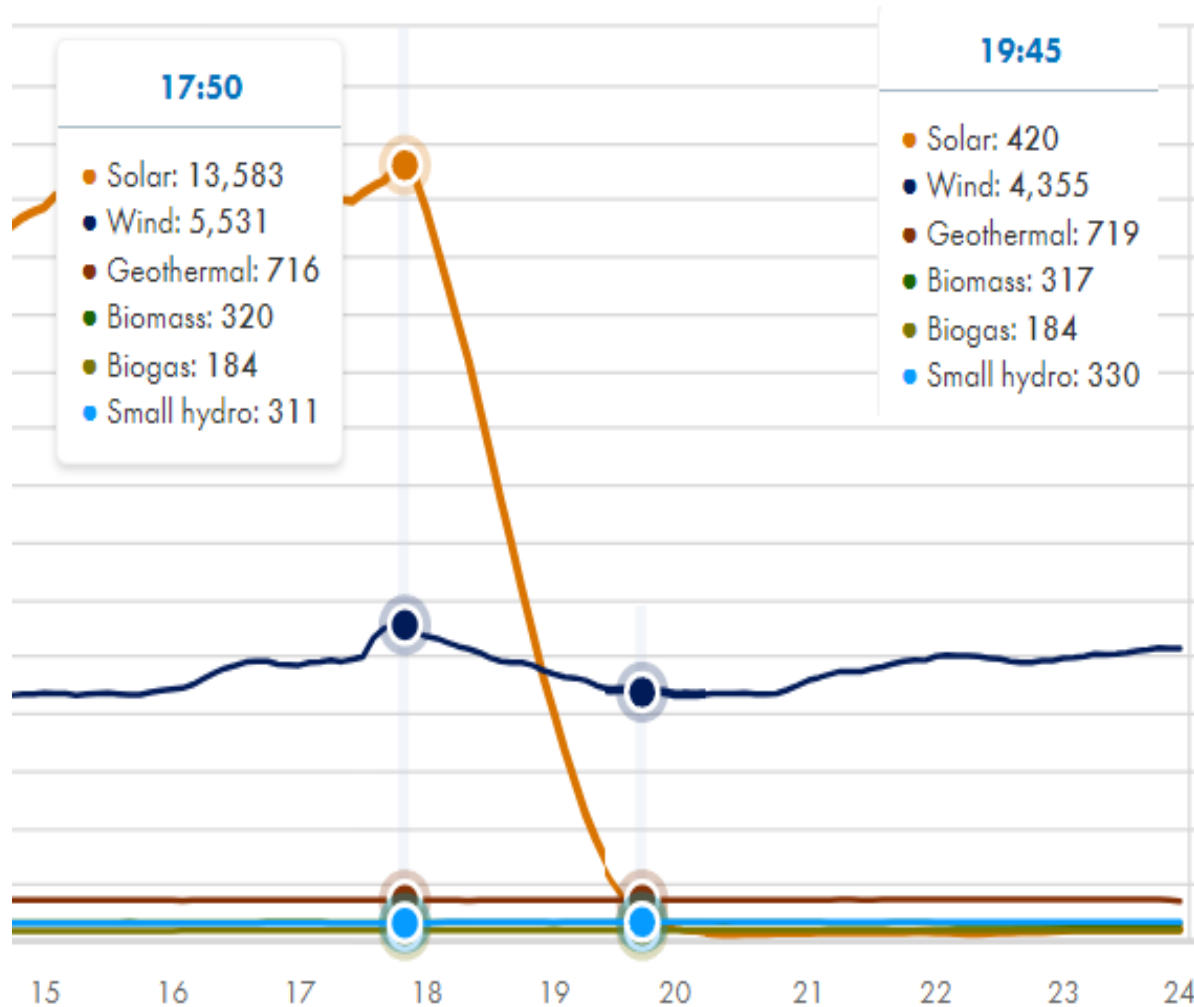
Hour Ending 1900



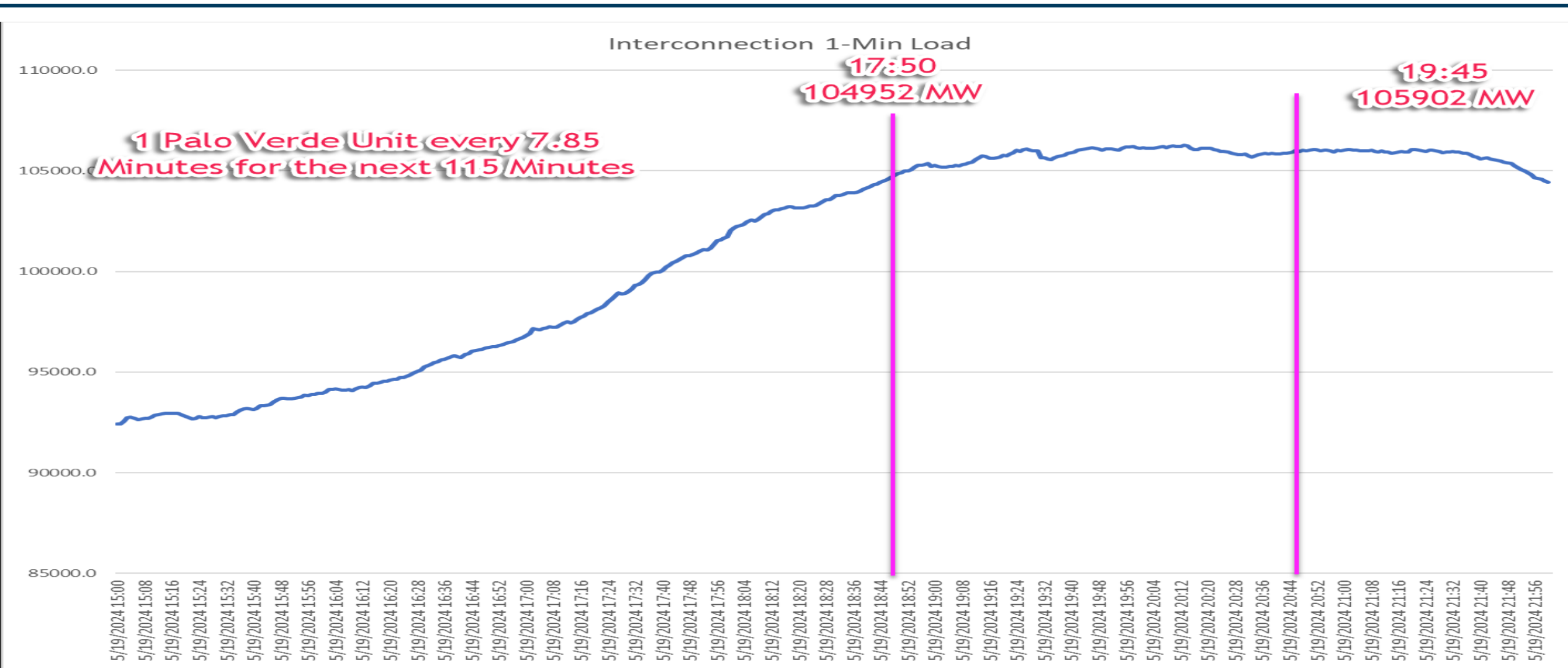
Frequency Profile



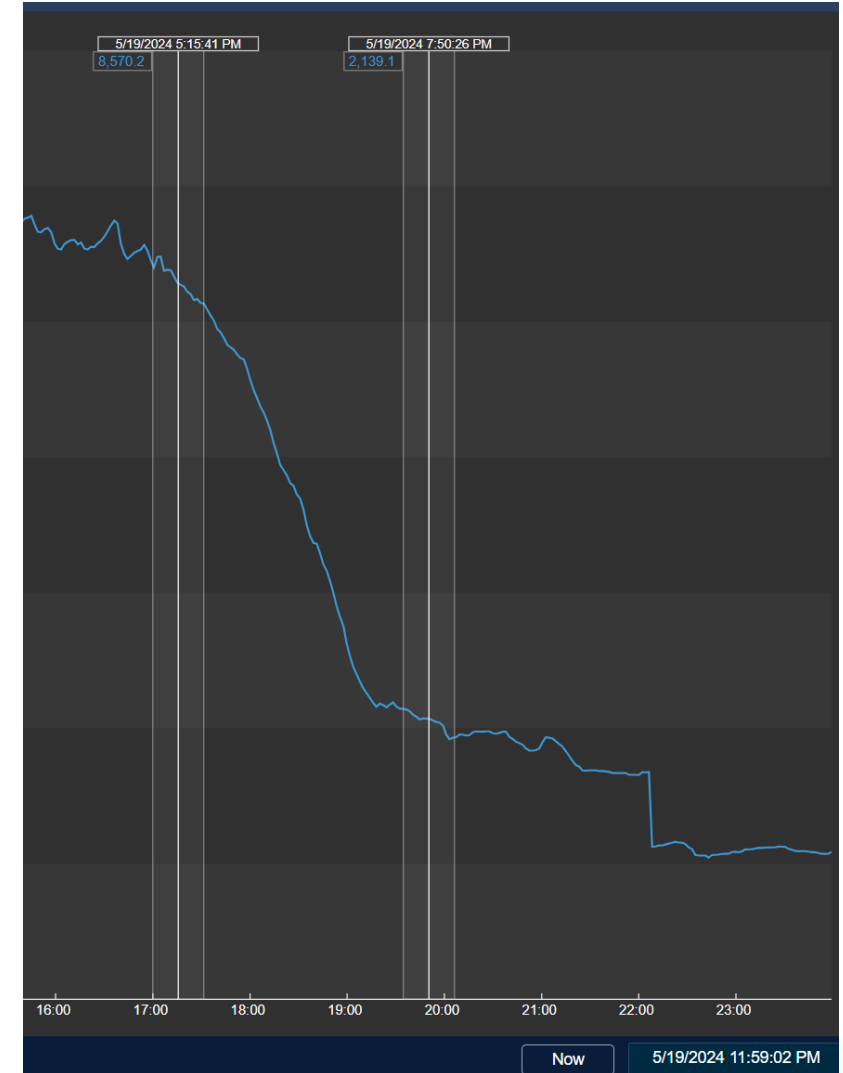
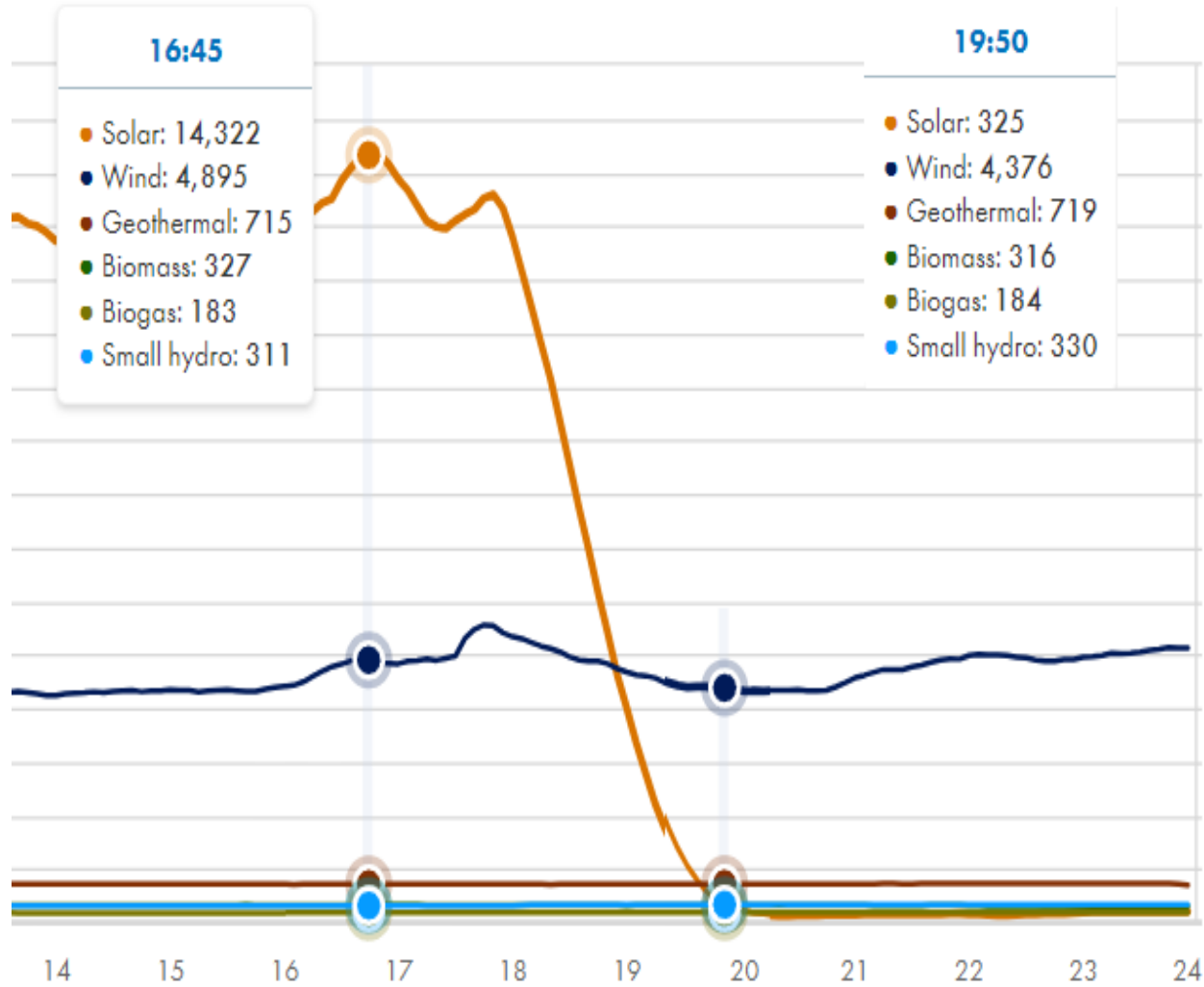
Solar Ramp 164 MW/Min for 115 Min (18,870 MW Loss)



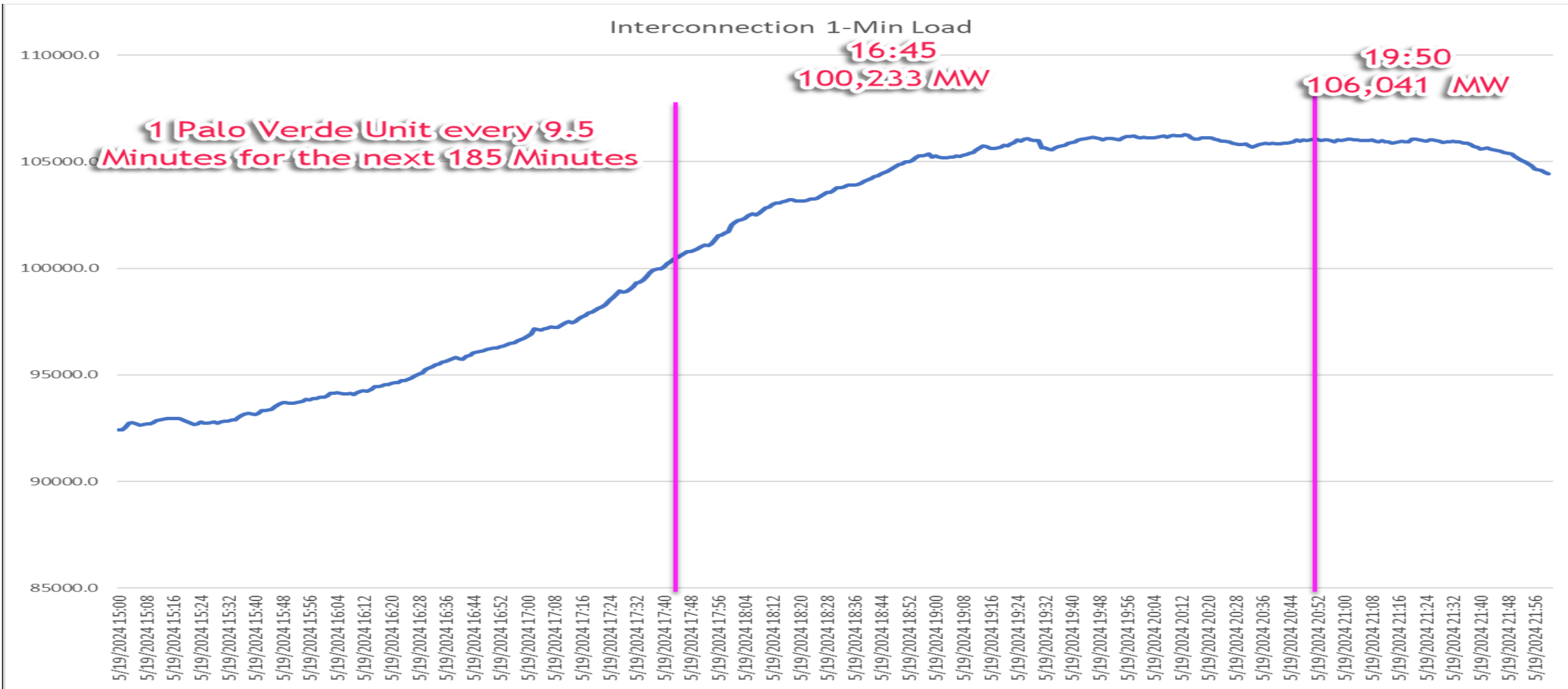
Interconnection Load (Increased by 950 MW) 172 MW/Min for 115 minutes



Solar Ramp 110 MW/Min for 185 Min (20,428 MW Loss)



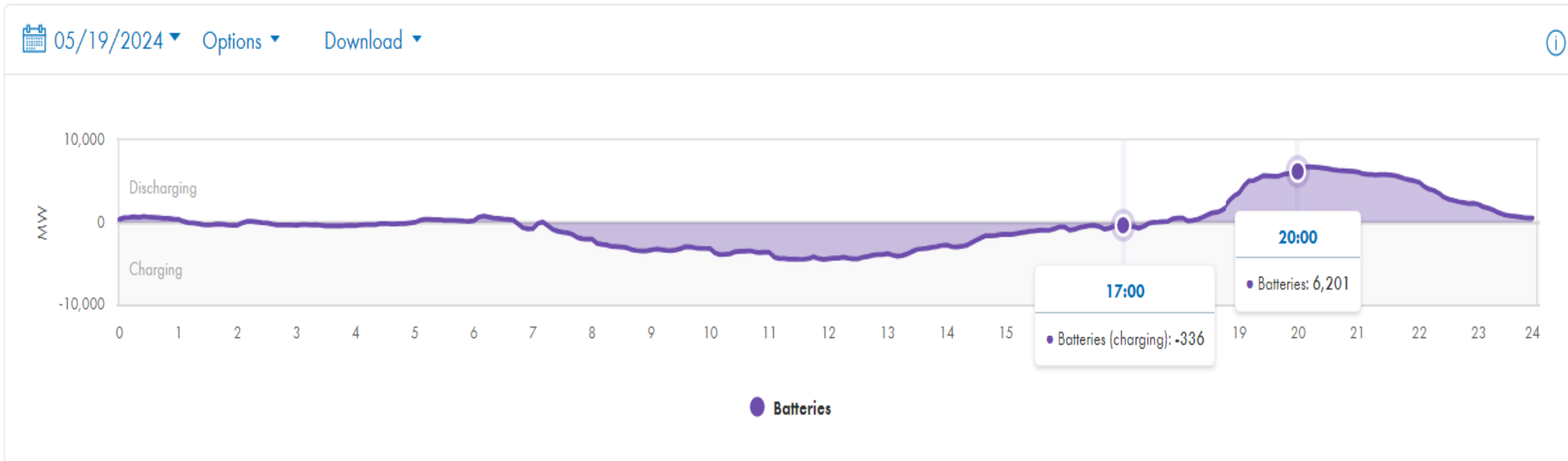
Interconnection Load (Increased by 5,808 MW) 142 MW/Min for 185 minutes



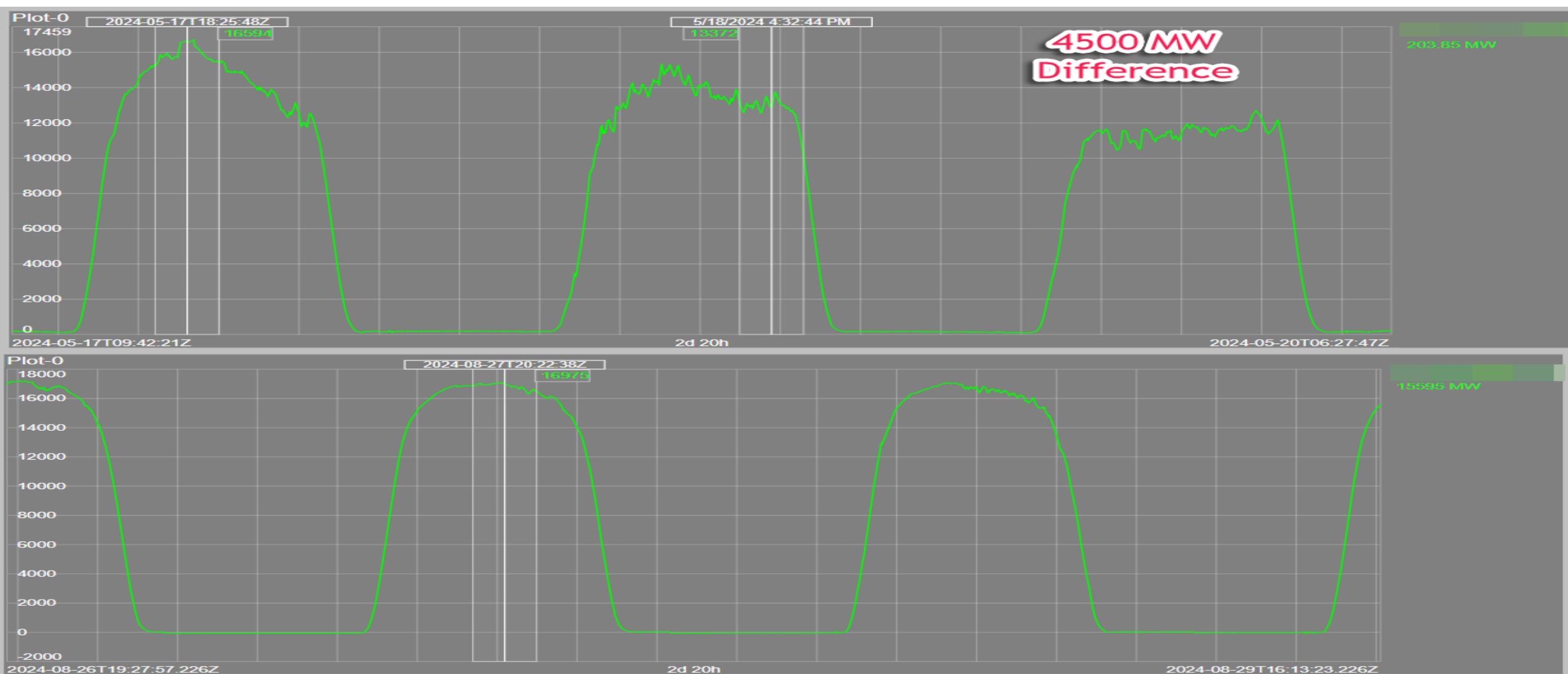
What Were Batteries Doing (CAISO Only)?

Batteries trend

Energy in megawatts in 5-minute increments. Displays stand-alone battery storage and some hybrids, including renewable components, wind and solar.



Solar Output Target Day vs. Clear Day



Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	149.79%	159.56%	169.11%	153.26%	135.07%	100.81%	118.91%	144.55%	155.69%	163.50%	154.16%	161.40%	152.27%	164.40%	168.63%	150.44%	96.24%	144.52%	164.15%	163.34%	140.92%	112.96%	121.22%	123.19%	144.50%
Feb	140.25%	158.40%	164.31%	160.18%	134.37%	80.64%	114.82%	152.25%	155.39%	154.45%	143.83%	151.22%	149.01%	165.20%	163.99%	143.92%	106.52%	76.58%	163.53%	163.13%	134.76%	112.50%	105.93%	119.32%	138.10%
Mar	130.47%	155.67%	163.61%	149.16%	123.57%	83.51%	118.36%	135.85%	152.08%	158.87%	151.77%	157.20%	153.43%	154.60%	162.13%	161.65%	149.08%	112.41%	119.59%	133.04%	157.30%	128.44%	105.56%	120.35%	139.07%
Apr	148.52%	158.60%	162.72%	158.54%	132.64%	91.17%	130.67%	138.78%	143.48%	155.01%	148.53%	157.66%	152.96%	147.93%	156.92%	152.06%	151.33%	157.21%	154.18%	142.87%	142.15%	112.94%	97.37%	106.62%	141.70%
May	118.34%	151.10%	159.71%	164.37%	141.83%	126.59%	120.10%	140.50%	143.63%	154.33%	146.00%	153.44%	154.84%	150.55%	148.14%	147.63%	116.63%	139.97%	148.52%	151.53%	146.41%	117.99%	93.84%	89.48%	138.56%
Jun	137.88%	154.55%	156.22%	163.00%	148.00%	123.99%	109.49%	137.15%	142.41%	143.13%	141.72%	166.08%	156.36%	160.11%	154.06%	154.77%	167.02%	151.31%	151.46%	155.40%	156.82%	146.21%	112.26%	112.23%	145.90%
Jul	127.96%	144.14%	148.45%	168.53%	151.58%	119.88%	119.70%	121.52%	133.15%	140.56%	119.10%	141.06%	159.17%	153.18%	160.00%	165.16%	162.18%	143.12%	147.54%	158.99%	145.63%	144.38%	107.87%	104.42%	141.14%
Aug	125.97%	152.17%	161.28%	164.53%	142.83%	117.52%	125.73%	136.14%	138.98%	130.65%	139.62%	144.63%	154.32%	156.09%	161.02%	163.99%	137.70%	150.10%	144.46%	153.45%	149.41%	101.33%	106.54%	116.35%	140.62%
Sep	125.12%	144.41%	152.90%	159.61%	136.41%	74.82%	119.38%	138.15%	144.45%	130.57%	145.94%	145.38%	150.79%	155.65%	159.66%	150.60%	159.59%	157.88%	130.10%	128.77%	116.96%	83.14%	101.91%	99.09%	133.80%
Oct	131.42%	154.92%	156.33%	168.01%	106.59%	85.29%	104.24%	146.43%	138.65%	133.92%	153.86%	155.69%	161.19%	159.03%	157.67%	149.37%	124.95%	111.19%	108.33%	143.24%	115.79%	105.76%	109.85%	111.55%	133.05%
Nov	130.78%	159.53%	149.74%	152.07%	117.97%	104.61%	130.62%	147.32%	151.03%	151.81%	149.24%	152.59%	154.29%	158.98%	154.59%	129.41%	90.77%	142.59%	148.07%	152.34%	129.70%	109.68%	81.22%	107.31%	135.68%
Dec	139.61%	158.49%	164.18%	158.04%	129.80%	90.79%	122.30%	149.04%	150.31%	152.94%	151.88%	148.52%	147.61%	154.46%	156.31%	112.30%	94.45%	154.90%	158.14%	158.82%	140.31%	123.13%	104.92%	123.44%	139.36%

Year

2013	2015	2017	2019	2021	2023
2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores



Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	146.86%	152.72%	155.95%	145.99%	116.98%	90.77%	101.38%	138.06%	141.32%	138.14%	142.53%	145.99%	151.83%	155.48%	160.07%	148.69%	103.46%	135.51%	151.39%	158.61%	135.92%	119.77%	116.18%	126.55%	136.67%
Feb	121.08%	139.76%	136.31%	137.74%	108.18%	71.61%	123.65%	159.07%	149.37%	158.00%	149.71%	135.48%	152.58%	133.74%	145.69%	124.33%	95.28%	114.27%	143.95%	154.06%	133.81%	109.54%	101.36%	116.47%	129.79%
Mar	131.79%	149.16%	138.48%	134.71%	120.24%	110.75%	102.37%	140.80%	147.13%	151.71%	143.17%	140.50%	146.49%	154.71%	140.01%	135.72%	134.04%	117.85%	140.13%	128.49%	147.79%	113.02%	104.88%	96.79%	132.11%
Apr	135.42%	153.51%	157.72%	160.09%	131.51%	129.62%	117.94%	135.73%	144.01%	147.69%	147.04%	146.64%	145.23%	149.77%	153.43%	151.98%	125.14%	136.53%	138.79%	123.65%	149.04%	111.85%	97.56%	97.53%	136.97%
May	148.51%	153.24%	145.24%	137.27%	119.40%	117.56%	106.83%	132.76%	147.64%	151.21%	143.61%	140.13%	145.48%	149.08%	142.63%	145.93%	143.66%	128.36%	148.61%	159.37%	155.05%	137.11%	124.49%	110.21%	138.89%
Jun	140.95%	155.32%	158.96%	150.76%	150.41%	140.15%	119.54%	145.02%	141.55%	153.63%	140.33%	150.21%	148.72%	156.72%	159.70%	155.31%	148.90%	144.45%	144.16%	142.25%	157.32%	148.42%	125.36%	123.81%	145.91%
Jul	136.84%	147.40%	161.76%	167.42%	160.18%	125.72%	129.42%	109.60%	133.26%	131.83%	146.21%	138.24%	149.92%	163.08%	156.38%	151.66%	147.35%	154.91%	146.06%	143.03%	142.54%	131.13%	95.47%	112.85%	140.93%
Aug	126.84%	142.04%	154.09%	161.36%	144.61%	123.74%	137.43%	127.44%	144.51%	138.00%	137.45%	141.99%	153.11%	150.51%	153.46%	155.68%	153.87%	140.42%	143.62%	147.92%	149.62%	101.99%	114.09%	94.95%	139.11%
Sep	133.84%	149.91%	156.99%	154.31%	131.20%	85.30%	128.76%	128.81%	145.44%	137.77%	148.11%	141.35%	137.31%	145.65%	153.18%	154.39%	149.51%	149.08%	129.72%	130.72%	119.91%	85.68%	107.75%	100.92%	133.57%
Oct	139.20%	151.26%	151.19%	141.75%	124.18%	75.67%	115.28%	141.39%	142.53%	149.17%	143.28%	141.82%	153.18%	153.05%	133.29%	130.78%	108.46%	129.73%	119.72%	143.52%	123.18%	95.45%	106.55%	102.97%	129.86%
Nov	122.67%	145.52%	142.94%	142.22%	102.10%	98.32%	115.74%	141.18%	124.75%	132.19%	145.79%	134.98%	146.19%	146.30%	109.64%	40.29%	77.09%	122.78%	146.03%	145.95%	118.47%	108.97%	109.51%	111.57%	122.13%
Dec	141.16%	155.70%	159.73%	156.57%	126.12%	129.92%	117.45%	123.91%	152.74%	147.71%	144.82%	135.07%	140.18%	139.43%	139.85%	104.63%	78.33%	143.42%	163.85%	164.78%	135.99%	116.39%	110.87%	112.06%	135.03%



Year	2013	2015	2017	2019	2021	2023
	2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	136.97%	168.69%	167.27%	156.39%	126.51%	115.02%	126.39%	145.43%	152.75%	153.68%	151.39%	150.99%	149.84%	136.92%	161.84%	-374.35%	79.98%	139.62%	165.76%	161.00%	135.73%	115.24%	109.21%	123.52%	118.99%
Feb	152.96%	161.21%	169.15%	142.25%	130.47%	120.42%	123.80%	152.16%	141.66%	152.48%	156.20%	154.62%	150.29%	153.76%	144.21%	147.62%	81.04%	118.22%	163.78%	158.58%	144.15%	128.97%	128.34%	131.38%	141.99%
Mar	137.07%	163.39%	164.13%	150.28%	139.34%	108.61%	129.58%	153.78%	151.76%	150.91%	161.61%	160.96%	154.29%	156.09%	154.26%	143.80%	128.20%	122.53%	126.10%	147.16%	148.48%	105.28%	98.64%	96.29%	139.69%
Apr	120.00%	152.18%	130.15%	130.44%	123.20%	94.52%	123.68%	144.41%	131.20%	142.20%	147.57%	152.70%	150.97%	156.25%	153.91%	136.06%	125.75%	99.93%	131.79%	122.37%	144.38%	119.71%	108.51%	114.99%	131.54%
May	137.75%	160.36%	166.76%	158.83%	137.64%	120.64%	149.49%	156.02%	154.12%	149.25%	151.77%	157.79%	165.27%	154.86%	147.13%	156.07%	157.93%	145.49%	141.89%	148.15%	153.45%	124.13%	102.42%	90.80%	145.33%
Jun	114.66%	140.52%	145.78%	149.00%	136.09%	116.71%	118.71%	125.10%	128.57%	131.03%	140.57%	143.38%	149.22%	161.39%	146.67%	131.44%	131.65%	131.35%	140.87%	135.96%	113.56%	125.87%	98.51%	92.09%	131.20%
Jul	119.04%	154.24%	159.22%	168.74%	142.59%	141.28%	129.07%	131.80%	138.54%	122.67%	136.72%	142.58%	146.98%	146.47%	150.15%	154.41%	142.88%	149.37%	152.99%	146.01%	142.11%	139.31%	100.91%	116.36%	140.60%
Aug	138.14%	154.60%	164.11%	155.52%	139.91%	123.77%	132.88%	133.93%	146.58%	138.27%	137.74%	141.80%	139.70%	150.08%	141.87%	146.26%	149.17%	147.73%	145.32%	139.08%	138.06%	97.84%	99.06%	107.60%	137.88%
Sep	119.59%	153.86%	157.79%	160.07%	135.39%	87.29%	131.61%	143.70%	140.05%	158.48%	153.18%	50.56%	145.90%	155.97%	149.71%	143.58%	134.72%	130.66%	129.93%	138.12%	125.35%	84.86%	76.29%	91.39%	129.08%
Oct	119.99%	139.74%	156.39%	134.26%	126.40%	78.00%	125.98%	141.23%	129.68%	139.73%	153.20%	149.87%	151.68%	145.74%	136.29%	149.80%	121.86%	125.30%	133.44%	141.21%	112.21%	90.93%	118.14%	109.65%	130.45%
Nov	140.62%	149.18%	151.64%	139.08%	124.20%	108.24%	138.46%	134.00%	141.45%	145.71%	137.94%	141.20%	147.49%	136.91%	125.86%	61.06%	96.44%	152.93%	151.98%	148.26%	136.21%	132.21%	127.70%	122.87%	132.98%
Dec	147.67%	159.93%	153.04%	161.55%	127.78%	114.09%	140.63%	132.22%	126.81%	131.10%	138.40%	133.51%	143.09%	147.20%	144.03%	88.51%	79.54%	143.91%	159.64%	162.04%	153.45%	120.43%	125.69%	112.60%	135.29%



Year	2013	2015	2017	2019	2021	2023
	2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	145.90%	160.86%	164.09%	160.54%	118.63%	105.04%	115.81%	140.44%	136.13%	150.09%	147.24%	143.20%	143.08%	155.17%	144.16%	103.55%	65.88%	118.73%	159.01%	154.76%	143.68%	122.60%	124.79%	117.09%	135.02%
Feb	149.21%	164.69%	163.05%	149.90%	130.80%	115.00%	126.33%	130.56%	129.55%	145.82%	156.18%	153.07%	151.76%	155.93%	158.92%	125.35%	53.24%	109.61%	150.15%	159.74%	138.32%	126.17%	126.64%	123.83%	137.24%
Mar	144.01%	152.94%	152.08%	157.57%	137.86%	111.34%	91.95%	140.04%	122.34%	145.02%	137.72%	155.57%	151.19%	145.97%	144.11%	136.22%	122.18%	98.13%	109.65%	132.78%	150.19%	112.12%	113.41%	116.42%	132.53%
Apr	138.56%	139.48%	155.82%	149.97%	146.04%	110.60%	126.27%	147.67%	136.94%	149.96%	155.32%	150.21%	153.39%	148.22%	164.25%	140.69%	150.58%	130.77%	125.31%	131.89%	140.05%	92.67%	79.93%	97.06%	135.90%
May	141.40%	158.65%	160.40%	153.56%	114.59%	109.41%	135.08%	148.16%	134.86%	139.60%	157.92%	155.69%	156.99%	150.18%	154.94%	140.54%	135.27%	132.39%	137.93%	141.73%	151.05%	92.97%	85.49%	114.21%	137.63%
Jun	141.51%	155.00%	154.54%	161.77%	147.60%	127.29%	147.27%	130.34%	146.65%	151.76%	142.58%	147.94%	144.20%	150.85%	149.67%	155.31%	162.25%	147.42%	142.51%	125.62%	134.92%	125.60%	105.26%	112.28%	142.09%
Jul	133.93%	151.76%	158.33%	152.30%	111.60%	123.59%	151.07%	138.98%	128.89%	135.37%	123.28%	147.79%	143.07%	150.06%	151.68%	151.26%	154.10%	153.86%	157.03%	137.59%	153.41%	118.80%	93.89%	113.96%	138.98%
Aug	130.43%	148.62%	159.67%	166.00%	126.25%	85.18%	140.23%	145.36%	134.28%	131.78%	141.71%	117.99%	127.18%	130.58%	148.60%	144.76%	148.84%	151.46%	140.45%	125.00%	125.03%	80.72%	90.25%	92.93%	130.55%
Sep	141.72%	152.43%	151.69%	148.04%	115.59%	69.67%	125.40%	142.18%	141.14%	157.06%	157.55%	152.50%	154.65%	149.53%	148.96%	147.31%	151.54%	126.67%	138.92%	145.21%	130.93%	103.69%	81.82%	105.47%	134.99%
Oct	137.85%	151.82%	155.79%	156.74%	129.44%	88.22%	113.59%	141.72%	131.83%	150.95%	159.82%	158.57%	147.24%	152.40%	151.90%	139.18%	112.71%	118.73%	132.59%	152.93%	140.25%	130.15%	116.68%	124.26%	137.31%
Nov	148.14%	157.79%	158.43%	158.01%	136.18%	88.48%	115.20%	124.43%	119.62%	144.31%	157.78%	141.19%	156.47%	119.79%	136.39%	86.21%	96.40%	147.08%	148.88%	162.80%	152.34%	133.15%	119.82%	124.13%	134.71%
Dec	158.98%	164.35%	166.12%	160.54%	151.88%	130.61%	119.82%	149.04%	136.68%	142.96%	145.53%	154.16%	156.85%	153.12%	139.62%	111.25%	110.06%	160.66%	170.66%	166.08%	151.68%	126.71%	130.29%	132.13%	145.41%

Filter icon, Copy icon, and Ellipsis icon

Year						
	2013	2015	2017	2019	2021	2023
	2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	154.34%	169.12%	168.16%	169.33%	157.35%	134.16%	138.60%	144.14%	125.34%	129.53%	142.27%	147.94%	144.60%	150.61%	156.37%	132.90%	98.44%	146.64%	166.04%	170.03%	155.92%	130.31%	126.99%	138.53%	145.74%
Feb	155.11%	164.09%	167.05%	169.20%	156.51%	139.33%	131.62%	136.53%	128.51%	132.14%	140.09%	149.65%	139.78%	122.54%	128.39%	117.48%	118.52%	116.73%	162.61%	171.42%	142.74%	143.04%	129.72%	133.12%	141.50%
Mar	146.26%	159.33%	164.93%	159.00%	144.02%	136.45%	140.80%	129.87%	130.40%	126.17%	127.04%	153.15%	146.68%	149.88%	138.57%	134.11%	119.57%	117.02%	128.48%	142.06%	144.75%	138.69%	132.32%	131.94%	139.23%
Apr	150.34%	160.13%	158.48%	161.71%	156.91%	143.93%	160.15%	135.92%	122.54%	142.76%	135.29%	153.19%	155.21%	154.46%	154.35%	146.55%	139.98%	127.53%	130.60%	141.36%	160.05%	137.37%	128.63%	113.47%	144.62%
May	144.73%	163.88%	160.23%	168.90%	155.59%	139.67%	139.62%	137.67%	145.05%	140.84%	147.23%	152.25%	156.86%	150.81%	149.92%	151.51%	141.29%	134.81%	130.63%	147.02%	155.03%	136.10%	132.20%	122.59%	146.02%
Jun	145.86%	151.38%	161.06%	172.20%	160.52%	110.66%	150.34%	146.92%	159.40%	157.92%	126.29%	163.00%	153.54%	152.68%	142.66%	148.28%	152.24%	144.63%	156.62%	160.30%	139.76%	145.64%	139.15%	123.30%	148.51%
Jul	140.62%	151.92%	162.32%	169.03%	149.96%	132.25%	132.63%	149.62%	136.40%	128.41%	139.13%	140.90%	142.45%	140.45%	152.79%	136.45%	151.48%	141.33%	155.53%	144.31%	138.45%	140.75%	111.61%	125.63%	142.27%
Aug	147.55%	155.43%	163.31%	158.11%	134.40%	128.97%	130.28%	143.73%	153.69%	156.87%	156.24%	128.04%	131.06%	130.52%	145.51%	133.97%	148.37%	152.24%	156.80%	132.01%	150.63%	118.32%	100.72%	115.63%	140.52%
Sep	136.73%	158.14%	162.97%	163.24%	151.93%	109.38%	138.94%	155.55%	120.11%	149.06%	130.04%	148.47%	152.65%	136.21%	141.85%	144.11%	123.48%	124.01%	133.73%	146.99%	127.59%	114.94%	126.15%	125.01%	138.39%
Oct	126.68%	153.70%	161.98%	161.45%	127.20%	100.82%	115.35%	128.74%	96.10%	142.22%	146.07%	155.37%	159.47%	153.42%	149.20%	141.53%	84.48%	115.03%	136.21%	135.36%	118.54%	117.49%	121.55%	121.37%	132.05%
Nov	141.19%	158.99%	156.81%	152.75%	131.30%	106.86%	144.24%	120.81%	142.26%	146.41%	149.87%	152.54%	125.45%	138.54%	123.11%	106.04%	96.09%	142.80%	155.10%	159.60%	147.44%	129.12%	124.62%	144.80%	137.36%
Dec	166.36%	172.53%	171.63%	156.09%	137.61%	123.82%	148.30%	136.95%	139.64%	152.82%	154.53%	160.29%	161.35%	166.68%	142.82%	77.90%	121.94%	158.46%	168.07%	170.46%	166.33%	142.37%	145.41%	153.11%	149.81%



Year	
	<div>201320152017201920212023</div>
	<div>201420162018202020222024</div>

Monthly Average CPS1 Scores



Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	165.40%	173.75%	165.22%	160.27%	138.20%	135.77%	146.45%	149.22%	137.99%	153.74%	164.96%	161.47%	164.45%	163.36%	147.78%	111.10%	112.66%	158.01%	168.18%	169.28%	148.54%	141.54%	141.64%	152.82%	151.33%
Feb	144.42%	161.90%	167.02%	163.56%	160.62%	141.60%	128.43%	133.06%	118.97%	143.57%	152.92%	161.62%	157.83%	140.47%	145.05%	136.59%	102.95%	109.67%	166.21%	159.96%	153.80%	138.12%	147.53%	140.98%	144.87%
Mar	155.23%	167.24%	153.32%	155.50%	131.60%	121.06%	141.48%	131.81%	115.33%	129.87%	146.13%	150.80%	148.89%	145.51%	134.93%	129.76%	102.64%	103.33%	125.33%	148.97%	154.57%	142.16%	141.55%	140.80%	138.24%
Apr	151.42%	160.89%	170.77%	168.34%	151.23%	136.26%	139.18%	131.98%	147.95%	143.22%	149.82%	154.30%	155.80%	147.68%	152.69%	142.68%	133.82%	110.59%	122.01%	159.90%	144.78%	123.29%	125.12%	130.18%	143.91%
May	151.99%	172.18%	166.72%	169.91%	162.82%	143.31%	146.75%	132.59%	151.85%	159.09%	150.54%	153.71%	157.53%	155.29%	153.02%	140.35%	132.76%	129.68%	107.55%	157.76%	156.72%	136.61%	132.59%	135.11%	148.18%
Jun	143.08%	167.27%	167.30%	174.49%	162.29%	159.82%	158.71%	154.71%	169.47%	158.53%	150.09%	155.51%	165.45%	154.04%	161.28%	150.69%	162.07%	160.42%	138.13%	158.32%	157.10%	158.37%	139.98%	144.16%	157.14%
Jul	151.15%	164.16%	166.24%	175.91%	158.78%	157.51%	161.29%	163.11%	150.58%	143.27%	133.21%	148.93%	151.54%	136.95%	153.54%	151.69%	155.17%	144.12%	163.22%	153.90%	146.41%	132.49%	114.00%	135.73%	150.54%
Aug	152.79%	163.22%	167.33%	167.28%	161.96%	142.41%	163.97%	143.75%	152.68%	147.25%	144.17%	136.56%	125.29%	144.33%	147.08%	145.40%	147.11%	149.93%	155.07%	142.30%	139.27%	131.61%	123.24%	131.89%	146.91%
Sep	146.93%	166.17%	166.60%	161.64%	146.92%	124.16%	149.71%	136.49%	144.37%	161.51%	141.04%	150.77%	153.05%	149.79%	154.62%	161.98%	144.58%	122.84%	134.45%	145.84%	131.30%	135.64%	140.64%	150.52%	146.73%
Oct	151.73%	171.30%	173.01%	171.72%	154.73%	135.88%	144.50%	132.35%	130.77%	152.56%	148.66%	153.92%	159.17%	155.15%	156.94%	136.52%	102.83%	108.38%	160.86%	143.94%	145.08%	146.63%	137.73%	148.66%	146.79%
Nov	154.31%	168.79%	171.57%	167.73%	159.50%	149.54%	149.80%	134.00%	151.07%	151.19%	160.93%	160.83%	148.03%	156.87%	131.42%	117.75%	133.00%	162.10%	162.88%	168.38%	158.99%	156.56%	157.55%	149.08%	153.41%
Dec	157.76%	166.13%	171.51%	168.36%	159.54%	152.95%	158.30%	142.76%	147.25%	150.25%	149.63%	159.73%	158.96%	160.20%	154.97%	106.08%	141.75%	170.57%	167.92%	164.86%	158.01%	152.67%	147.62%	151.48%	154.97%



Year

2013	2015	2017	2019	2021	2023
2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	169.66%	168.35%	174.66%	164.60%	158.78%	145.83%	146.67%	139.98%	141.08%	151.35%	151.77%	159.72%	164.48%	153.24%	152.28%	125.59%	129.85%	155.09%	171.25%	164.58%	165.77%	155.76%	153.14%	156.72%	155.01%
Feb	158.99%	173.98%	174.03%	171.65%	162.50%	157.26%	145.30%	129.16%	143.36%	143.09%	154.51%	146.06%	146.04%	145.53%	156.27%	143.14%	104.68%	142.25%	168.84%	175.54%	162.66%	151.15%	152.96%	149.81%	152.45%
Mar	157.42%	170.96%	164.93%	165.14%	160.67%	145.35%	152.07%	140.19%	121.50%	131.99%	141.71%	143.30%	147.81%	153.86%	158.06%	145.43%	125.06%	106.34%	125.43%	163.00%	165.46%	154.82%	154.88%	150.81%	147.76%
Apr	156.07%	164.41%	163.93%	172.34%	137.32%	138.95%	139.28%	129.00%	136.09%	145.94%	149.08%	145.34%	152.63%	143.96%	137.17%	128.05%	121.79%	109.41%	123.25%	165.98%	163.89%	143.03%	125.57%	141.38%	143.08%
May	155.47%	166.13%	168.08%	168.29%	153.67%	141.65%	152.21%	142.72%	151.07%	153.49%	154.93%	158.81%	153.03%	154.92%	153.48%	146.49%	145.31%	146.11%	139.38%	168.06%	157.70%	145.43%	138.09%	139.11%	152.23%
Jun	143.26%	161.12%	166.61%	170.94%	159.53%	138.13%	151.74%	156.47%	147.71%	160.23%	147.84%	156.22%	154.79%	159.38%	155.88%	149.37%	147.26%	147.80%	147.15%	153.28%	142.30%	151.41%	141.58%	135.85%	151.91%
Jul	147.07%	161.50%	169.77%	169.80%	160.59%	142.86%	156.66%	152.53%	156.63%	150.87%	138.70%	146.05%	153.78%	151.18%	152.84%	146.80%	155.77%	149.12%	148.28%	152.05%	153.63%	138.65%	144.87%	141.60%	151.73%
Aug	149.00%	164.83%	162.45%	165.39%	163.45%	131.78%	157.64%	150.79%	157.59%	162.76%	135.65%	138.80%	152.04%	159.69%	154.75%	153.71%	156.06%	152.23%	148.64%	121.92%	148.87%	135.85%	132.61%	146.65%	150.13%
Sep	143.84%	158.02%	152.99%	161.98%	154.48%	128.83%	154.12%	132.84%	142.40%	150.73%	143.71%	144.43%	145.22%	149.94%	140.73%	140.48%	138.36%	137.40%	147.82%	136.13%	139.76%	132.16%	135.77%	134.39%	143.61%
Oct	154.02%	163.50%	157.28%	163.21%	149.21%	124.97%	138.21%	124.64%	132.07%	140.93%	157.05%	155.63%	157.77%	149.01%	151.51%	137.29%	68.62%	98.71%	153.44%	158.71%	148.81%	149.07%	148.34%	155.87%	143.24%
Nov	160.31%	157.01%	167.33%	172.03%	153.43%	144.68%	146.81%	129.92%	147.93%	149.76%	146.99%	146.68%	151.18%	151.55%	130.06%	125.13%	156.50%	153.11%	154.93%	162.54%	158.12%	150.42%	153.62%	157.72%	151.16%
Dec	163.91%	170.75%	170.10%	163.11%	148.00%	145.79%	140.05%	135.64%	147.19%	155.76%	147.95%	142.60%	154.06%	145.37%	136.56%	106.81%	151.73%	159.30%	166.77%	168.65%	159.57%	158.07%	157.44%	153.23%	152.02%



Year					
	2013	2015	2017	2019	2021
	2014	2016	2018	2020	2022
					2023
					2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	169.79%	172.50%	172.46%	166.53%	152.00%	148.39%	150.67%	142.66%	138.06%	146.56%	150.90%	160.84%	151.74%	153.22%	138.10%	98.15%	128.78%	164.33%	171.72%	169.59%	158.28%	153.49%	155.77%	160.47%	153.13%
Feb	166.53%	177.90%	169.74%	169.51%	164.85%	155.28%	151.10%	132.09%	137.50%	150.09%	151.55%	156.32%	164.90%	158.67%	145.68%	119.67%	70.70%	150.91%	173.23%	165.27%	159.22%	154.03%	159.95%	156.97%	152.57%
Mar	162.99%	172.22%	163.23%	169.66%	165.13%	163.03%	160.13%	147.88%	135.74%	150.81%	144.97%	147.12%	137.42%	148.95%	137.03%	133.92%	117.11%	117.16%	150.22%	170.02%	162.13%	150.89%	159.11%	160.78%	151.15%
Apr	157.27%	159.81%	161.51%	169.64%	160.02%	168.43%	154.62%	138.93%	148.40%	151.34%	138.37%	130.98%	148.70%	149.81%	146.18%	137.03%	130.62%	112.24%	138.50%	159.81%	158.57%	153.92%	145.53%	141.93%	148.42%
May	157.38%	166.27%	168.34%	164.30%	164.69%	157.37%	151.77%	147.31%	146.69%	150.14%	136.03%	141.43%	152.23%	146.35%	146.18%	157.12%	147.51%	144.88%	144.71%	160.43%	160.48%	145.19%	140.32%	147.91%	151.88%
Jun	152.66%	165.11%	159.66%	167.81%	163.52%	146.26%	158.38%	153.67%	147.71%	148.69%	141.45%	141.19%	146.12%	153.70%	152.83%	146.83%	147.47%	148.25%	151.16%	151.79%	142.09%	149.47%	135.70%	128.64%	150.01%
Jul	156.94%	171.07%	173.68%	179.91%	166.86%	151.07%	162.71%	165.87%	153.66%	138.38%	137.06%	144.47%	158.28%	156.89%	156.16%	152.85%	151.36%	149.51%	151.74%	135.41%	142.20%	120.99%	128.04%	142.65%	151.99%
Aug	159.34%	158.39%	161.18%	170.41%	163.83%	150.82%	158.17%	153.68%	152.54%	139.80%	128.94%	142.22%	143.99%	143.84%	135.51%	145.55%	130.57%	151.01%	137.54%	121.24%	136.87%	136.27%	130.61%	149.46%	145.91%
Sep	142.82%	155.83%	155.99%	164.19%	148.34%	126.84%	160.19%	142.49%	148.77%	143.29%	146.92%	129.42%	150.20%	137.32%	132.53%	144.82%	142.75%	133.92%	119.21%	133.24%	127.44%	139.55%	138.91%	144.46%	142.06%
Oct	139.36%	154.36%	160.67%	158.06%	154.94%	145.35%	153.28%	132.42%	122.27%	133.54%	139.29%	136.52%	129.06%	135.43%	145.65%	152.20%	102.52%	133.44%	136.96%	138.29%	130.67%	148.00%	141.17%	134.20%	139.90%
Nov	164.20%	168.35%	167.56%	163.72%	154.36%	135.36%	148.31%	141.20%	151.84%	146.11%	148.41%	141.07%	146.75%	150.29%	142.00%	78.65%	146.63%	158.31%	155.71%	164.22%	158.83%	153.67%	149.68%	148.52%	149.32%
Dec	158.59%	164.99%	167.01%	167.55%	158.88%	141.31%	140.47%	144.92%	146.33%	156.53%	148.39%	143.66%	157.36%	154.95%	143.92%	83.95%	130.76%	173.28%	168.72%	164.35%	164.46%	153.64%	156.23%	155.75%	151.92%



Year

2013	2015	2017	2019	2021	2023
2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores



Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	171.27%	172.15%	168.63%	167.55%	161.94%	154.72%	135.61%	132.40%	147.24%	146.17%	157.85%	155.71%	151.72%	161.77%	137.58%	113.38%	115.02%	152.60%	172.81%	170.87%	172.41%	159.80%	156.62%	150.90%	153.61%
Feb	162.47%	162.47%	170.98%	166.40%	153.49%	146.89%	139.45%	135.22%	135.19%	140.15%	143.24%	147.50%	149.54%	146.16%	155.42%	125.95%	19.74%	134.23%	167.90%	163.97%	169.20%	157.64%	150.56%	152.10%	145.66%
Mar	161.70%	165.32%	165.64%	172.75%	148.68%	129.00%	140.39%	135.75%	125.27%	131.32%	149.60%	147.91%	154.99%	156.54%	146.70%	136.48%	89.83%	75.11%	126.68%	158.77%	163.06%	155.60%	140.50%	149.22%	142.78%
Apr	154.66%	162.48%	168.16%	169.75%	145.92%	145.07%	151.31%	127.40%	147.70%	141.06%	154.25%	153.26%	155.21%	158.84%	149.85%	139.49%	145.36%	85.05%	84.58%	154.08%	160.08%	153.74%	138.65%	144.66%	145.44%
May	161.09%	168.80%	171.43%	160.90%	164.38%	163.79%	148.81%	136.86%	155.57%	162.90%	159.97%	161.60%	151.91%	156.98%	153.96%	152.56%	150.19%	144.04%	132.55%	151.82%	156.51%	144.82%	138.29%	143.04%	153.87%
Jun	157.48%	162.86%	162.13%	168.74%	161.92%	145.45%	156.72%	154.48%	157.53%	162.90%	155.51%	154.19%	146.29%	148.82%	155.78%	148.75%	159.71%	152.56%	147.63%	151.64%	142.41%	152.07%	133.22%	145.19%	153.50%
Jul	155.30%	163.79%	166.99%	173.44%	168.41%	149.15%	161.66%	158.21%	164.49%	159.94%	158.99%	152.13%	153.22%	145.27%	156.60%	148.05%	149.44%	146.15%	161.00%	151.16%	144.54%	151.26%	136.78%	147.49%	155.14%
Aug	146.38%	166.56%	166.50%	173.32%	163.10%	142.06%	158.85%	158.67%	164.31%	160.25%	147.39%	150.91%	152.71%	154.18%	163.35%	150.47%	153.85%	148.25%	154.44%	150.64%	150.77%	140.39%	140.04%	142.96%	154.18%
Sep	153.76%	165.47%	165.41%	168.25%	160.27%	126.06%	143.95%	145.14%	134.35%	151.35%	152.00%	147.13%	142.47%	144.21%	149.76%	144.01%	137.20%	116.96%	155.76%	147.31%	156.13%	150.74%	151.19%	153.45%	148.43%
Oct	151.69%	164.37%	164.71%	158.53%	156.05%	134.58%	120.49%	133.76%	126.28%	139.41%	144.58%	156.87%	145.00%	144.66%	139.86%	118.17%	67.87%	117.20%	157.64%	156.63%	165.51%	155.73%	151.41%	154.30%	142.72%
Nov	164.85%	162.14%	163.50%	164.00%	151.82%	135.78%	130.36%	128.71%	147.25%	142.55%	155.98%	161.59%	154.53%	155.47%	112.07%	89.28%	148.95%	162.14%	165.68%	170.06%	167.55%	164.35%	163.45%	167.01%	151.21%
Dec	164.11%	172.10%	175.58%	176.12%	166.80%	149.36%	146.54%	149.69%	143.28%	147.03%	148.15%	148.14%	156.39%	154.42%	147.85%	117.53%	154.86%	168.57%	171.99%	172.72%	167.61%	164.04%	159.18%	160.53%	157.61%



Year

2013	2015	2017	2019	2021	2023
2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	171.79%	171.68%	176.55%	164.68%	157.49%	147.65%	144.06%	144.26%	135.46%	154.04%	157.08%	167.50%	162.36%	156.09%	154.70%	110.44%	133.77%	165.06%	172.34%	174.35%	175.43%	168.17%	160.61%	164.85%	157.93%
Feb	173.73%	178.92%	174.88%	172.82%	161.08%	150.54%	159.80%	127.64%	141.04%	147.54%	157.95%	166.47%	162.31%	160.55%	160.68%	116.51%	73.45%	153.42%	169.30%	173.33%	173.88%	172.48%	163.82%	167.39%	156.65%
Mar	164.78%	171.38%	171.87%	168.85%	158.93%	141.76%	142.31%	136.47%	132.29%	128.10%	138.83%	147.96%	152.70%	145.31%	147.78%	137.38%	88.03%	99.19%	148.99%	173.72%	172.24%	160.43%	159.58%	156.38%	147.72%
Apr	162.04%	167.82%	172.17%	166.51%	149.35%	140.28%	152.19%	113.25%	118.25%	147.10%	150.92%	154.68%	156.10%	154.13%	144.15%	136.90%	121.08%	79.55%	94.79%	154.66%	165.24%	160.06%	153.90%	163.11%	144.93%
May	162.21%	167.18%	170.33%	166.26%	156.04%	149.01%	142.71%	116.14%	148.52%	152.13%	153.31%	159.37%	147.35%	154.83%	155.77%	145.18%	138.57%	132.11%	110.49%	161.94%	160.87%	155.77%	149.12%	153.22%	150.35%
Jun	154.57%	163.62%	164.29%	164.29%	159.82%	152.20%	149.80%	151.33%	149.48%	160.10%	157.15%	151.35%	146.98%	153.01%	150.36%	151.93%	147.14%	148.60%	135.37%	151.18%	150.40%	155.76%	142.94%	136.86%	152.02%
Jul	152.88%	161.69%	174.91%	174.12%	170.03%	166.59%	168.29%	155.47%	164.91%	157.91%	165.37%	164.35%	166.75%	163.36%	161.19%	154.29%	152.36%	157.71%	152.43%	163.86%	145.41%	149.87%	153.44%	157.32%	160.60%
Aug	157.71%	160.94%	170.80%	174.00%	169.03%	164.82%	162.28%	160.42%	158.38%	161.56%	158.55%	157.91%	159.10%	155.01%	148.71%	149.99%	143.63%	146.48%	158.96%	143.72%	162.66%	148.07%	146.68%	153.65%	157.21%
Sep	147.55%	162.84%	159.83%	168.65%	159.12%	145.10%	152.65%	142.22%	158.31%	159.11%	142.83%	135.83%	143.81%	146.44%	141.37%	143.41%	136.94%	129.47%	152.49%	156.39%	144.03%	153.16%	151.44%	154.74%	149.49%
Oct	155.42%	161.82%	162.34%	165.39%	153.97%	137.24%	133.52%	117.50%	141.03%	154.09%	154.05%	154.48%	157.07%	148.13%	148.23%	137.23%	77.87%	134.95%	152.93%	159.89%	157.35%	150.82%	160.92%	149.66%	146.91%
Nov	167.66%	167.26%	168.06%	167.36%	140.79%	133.63%	146.25%	145.22%	140.54%	152.08%	153.07%	151.78%	149.19%	154.42%	147.03%	75.32%	120.67%	154.33%	162.54%	169.49%	167.81%	162.37%	156.52%	157.41%	150.45%
Dec	163.57%	174.62%	174.35%	173.55%	158.44%	151.49%	145.62%	148.81%	152.94%	161.37%	161.61%	167.77%	165.90%	162.42%	138.33%	121.04%	155.66%	172.22%	177.77%	170.12%	172.71%	165.95%	160.36%	161.74%	160.77%

Filter Icon Save Icon More Icon

Year	2013	2015	2017	2019	2021	2023
	2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	160.21%	173.90%	173.05%	166.30%	152.16%	150.23%	147.23%	137.60%	145.72%	150.10%	158.90%	165.57%	160.26%	156.91%	151.28%	132.27%	132.78%	166.71%	175.64%	172.03%	173.02%	168.27%	157.26%	165.39%	158.03%
Feb	163.48%	172.71%	172.62%	170.96%	163.30%	159.81%	149.31%	129.46%	148.75%	163.47%	156.91%	156.90%	158.48%	155.39%	150.11%	107.79%	84.91%	157.60%	162.49%	169.40%	172.36%	161.27%	154.66%	160.93%	154.29%
Mar	169.45%	166.67%	167.17%	169.72%	153.89%	142.74%	140.95%	132.35%	131.20%	130.24%	139.20%	149.44%	141.40%	144.00%	139.43%	126.20%	102.30%	114.26%	139.29%	171.01%	167.51%	162.01%	157.21%	157.60%	146.47%
Apr	151.74%	161.53%	165.87%	164.50%	160.33%	148.22%	129.37%	106.67%	125.99%	141.90%	148.86%	145.37%	133.15%	137.84%	138.14%	130.19%	126.51%	70.08%	101.40%	157.03%	156.01%	150.78%	140.53%	138.36%	138.77%
May	154.12%	167.82%	168.80%	175.46%	169.22%	153.16%	146.41%	126.85%	154.30%	164.98%	155.01%	163.76%	158.07%	148.92%	143.32%	124.21%	123.52%	136.58%	123.20%	156.46%	170.20%	152.52%	147.99%	155.77%	151.69%
Jun	155.61%	165.26%	169.09%	171.43%	161.53%	161.56%	142.24%	129.73%	155.98%	161.39%	159.41%	156.62%	148.90%	152.31%	141.31%	153.67%	121.30%	119.11%	122.58%	147.64%	155.24%	159.70%	147.77%	148.00%	150.31%
Jul	142.73%	158.09%	166.43%	161.31%	158.45%	155.61%	148.77%	147.90%	152.68%	148.97%	155.98%	154.17%	149.65%	139.96%	145.57%	155.15%	139.60%	146.86%	136.73%	125.88%	122.18%	136.03%	140.70%	148.20%	147.40%
Aug	152.01%	155.63%	158.27%	169.13%	159.01%	155.91%	146.50%	150.64%	154.18%	151.56%	159.57%	157.47%	154.15%	150.16%	139.36%	130.34%	144.40%	139.55%	153.51%	137.99%	153.34%	142.85%	135.12%	149.56%	150.01%
Sep	143.59%	170.85%	167.08%	168.16%	167.65%	148.05%	139.45%	118.44%	131.27%	145.91%	156.87%	152.58%	138.82%	137.48%	137.37%	130.94%	108.91%	100.63%	138.04%	146.76%	158.34%	153.28%	143.13%	149.84%	143.89%
Oct	137.49%	147.20%	146.91%	133.87%	131.92%	89.40%	97.64%	122.94%	139.71%	122.64%	116.75%	126.62%	133.88%	128.11%	101.72%	92.33%	-24.28%	73.21%	152.05%	142.71%	130.82%	141.57%	148.64%	147.11%	120.04%
Nov	128.36%	142.38%	136.03%	139.57%	112.26%	93.50%	102.12%	133.18%	137.10%	139.93%	136.94%	145.28%	141.74%	127.48%	79.13%	21.64%	99.93%	141.97%	158.49%	146.74%	149.60%	159.50%	154.80%	158.58%	128.59%
Dec	145.34%	161.25%	157.07%	146.72%	136.33%	111.22%	109.20%	133.38%	141.13%	138.47%	135.13%	138.47%	134.25%	129.45%	72.79%	36.33%	110.63%	154.51%	157.75%	155.57%	149.84%	154.35%	153.64%	162.53%	134.39%



Year

2013	2015	2017	2019	2021	2023
2014	2016	2018	2020	2022	2024

Monthly Average CPS1 Scores

Month/Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan	159.81%	165.04%	164.30%	166.15%	158.24%	134.72%	149.13%	129.04%	139.76%	140.87%	146.55%	152.42%	150.66%	147.53%	138.53%	104.46%	142.77%	156.84%	170.78%	170.00%	167.78%	160.73%	156.38%	157.90%	151.27%
Feb	164.06%	165.29%	166.06%	169.37%	159.22%	153.65%	139.34%	139.50%	132.89%	131.96%	142.22%	140.60%	137.99%	135.79%	110.75%	91.45%	98.84%	156.78%	161.57%	165.02%	162.78%	157.08%	151.37%	154.40%	145.33%
Mar	165.08%	173.58%	172.22%	172.44%	163.86%	146.92%	144.28%	129.93%	141.75%	124.80%	136.51%	137.26%	125.90%	122.05%	124.24%	112.66%	86.85%	76.76%	133.63%	166.19%	169.10%	171.49%	163.20%	158.22%	142.45%
Apr	159.01%	155.09%	164.59%	154.81%	152.83%	147.42%	131.89%	121.39%	120.61%	129.12%	134.50%	129.16%	121.41%	134.25%	128.70%	117.39%	114.39%	55.23%	57.07%	139.38%	153.05%	154.29%	151.77%	147.11%	132.27%
May	147.04%	159.38%	159.99%	160.38%	149.41%	148.57%	121.37%	111.18%	128.17%	142.31%	137.62%	138.31%	130.60%	132.11%	124.81%	128.07%	107.62%	86.94%	52.08%	135.79%	158.62%	162.05%	148.93%	148.54%	134.16%
Jun	150.76%	162.52%	162.66%	155.61%	157.80%	144.96%	122.29%	118.68%	136.56%	144.22%	140.62%	146.32%	139.00%	132.22%	120.74%	132.67%	118.76%	128.07%	119.04%	147.70%	142.29%	149.97%	152.03%	146.40%	140.50%

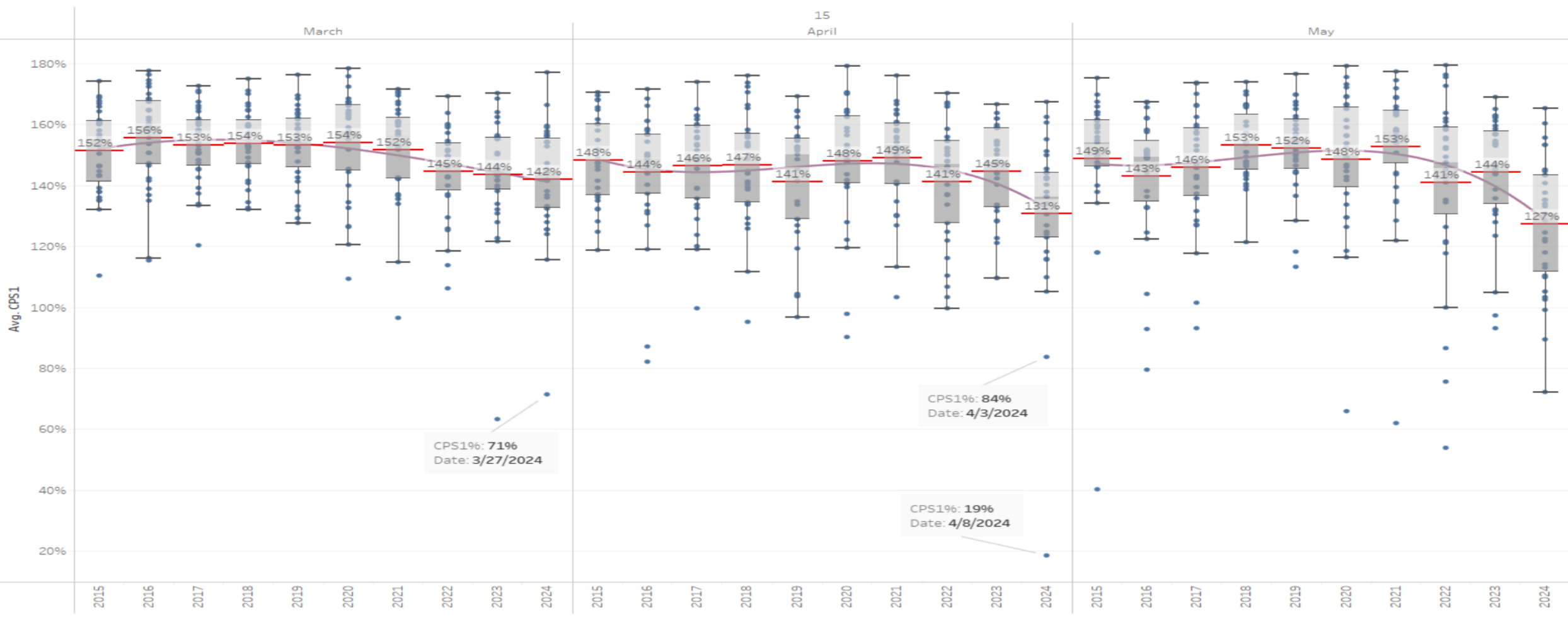


Year

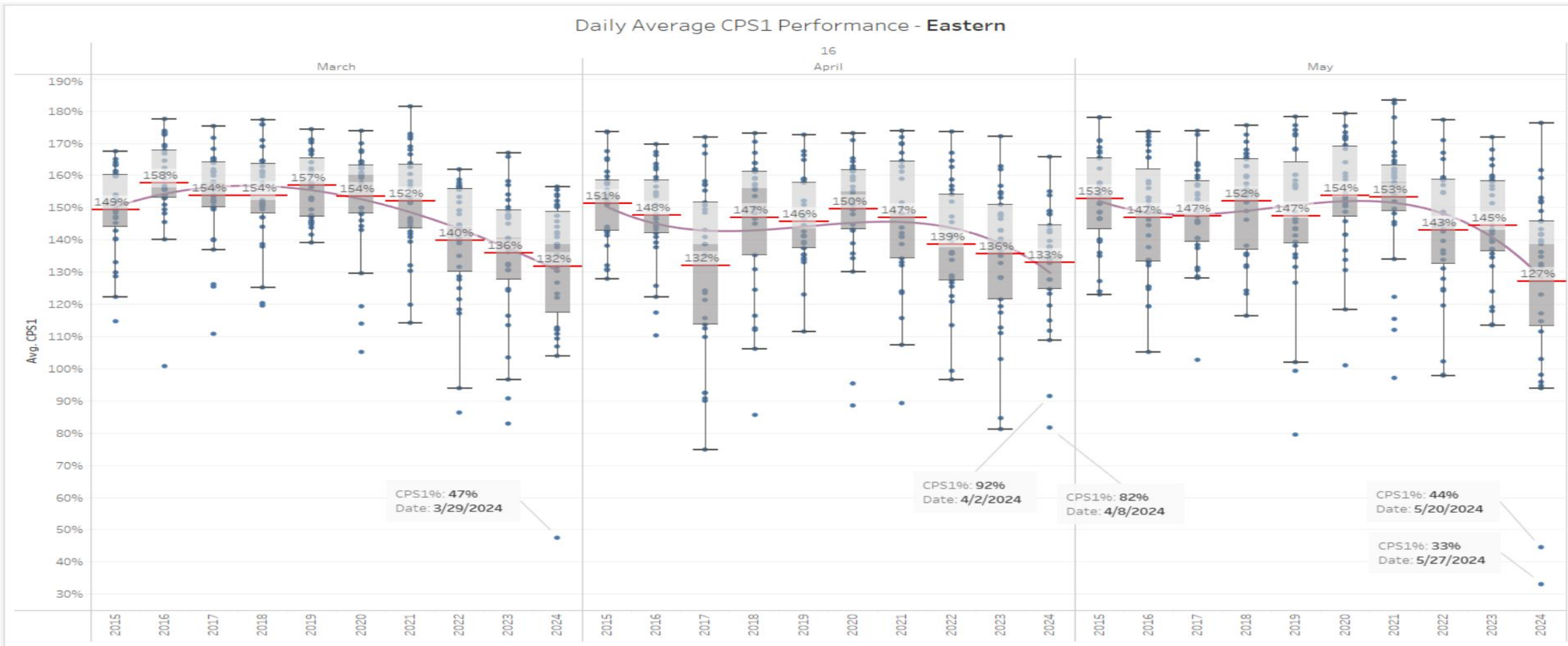
2013	2015	2017	2019	2021	2023
2014	2016	2018	2020	2022	2024

Impacts on the Eastern Interconnection

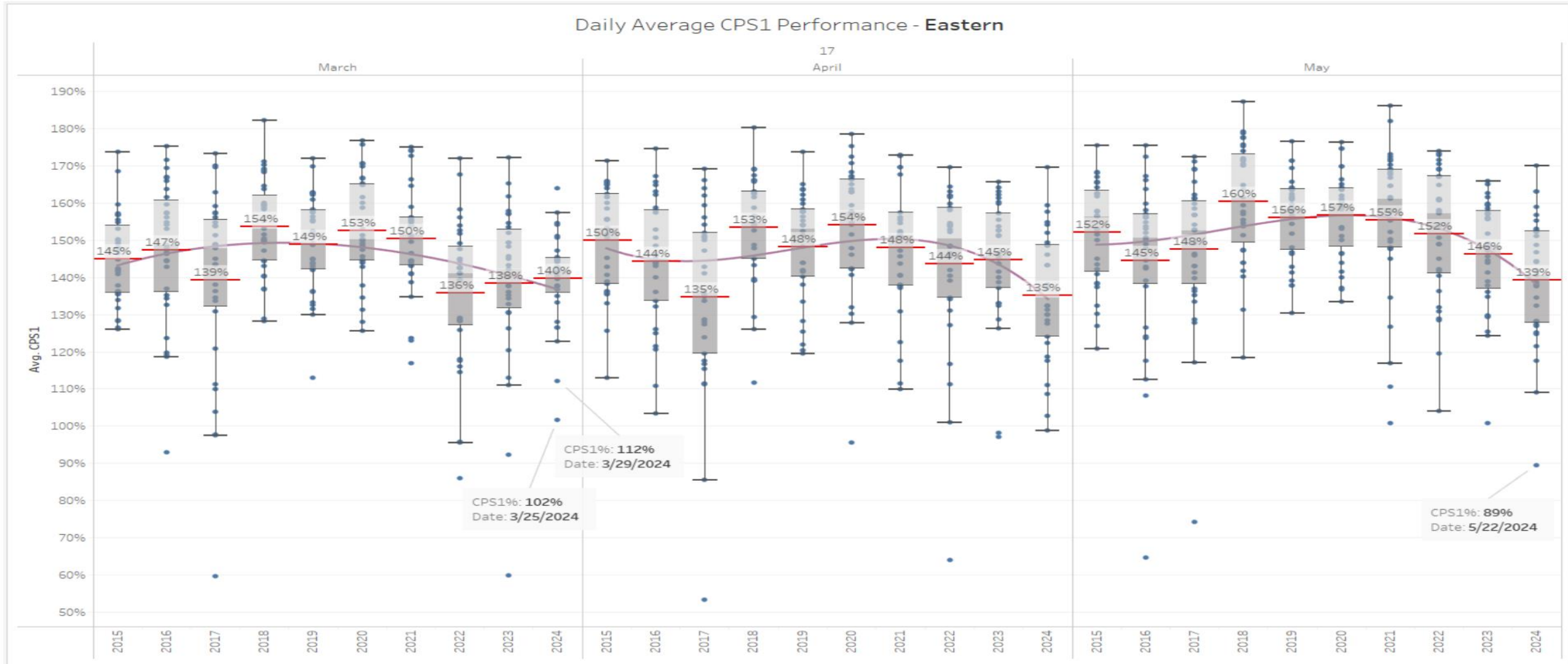
Daily Average CPS1 Performance - Eastern



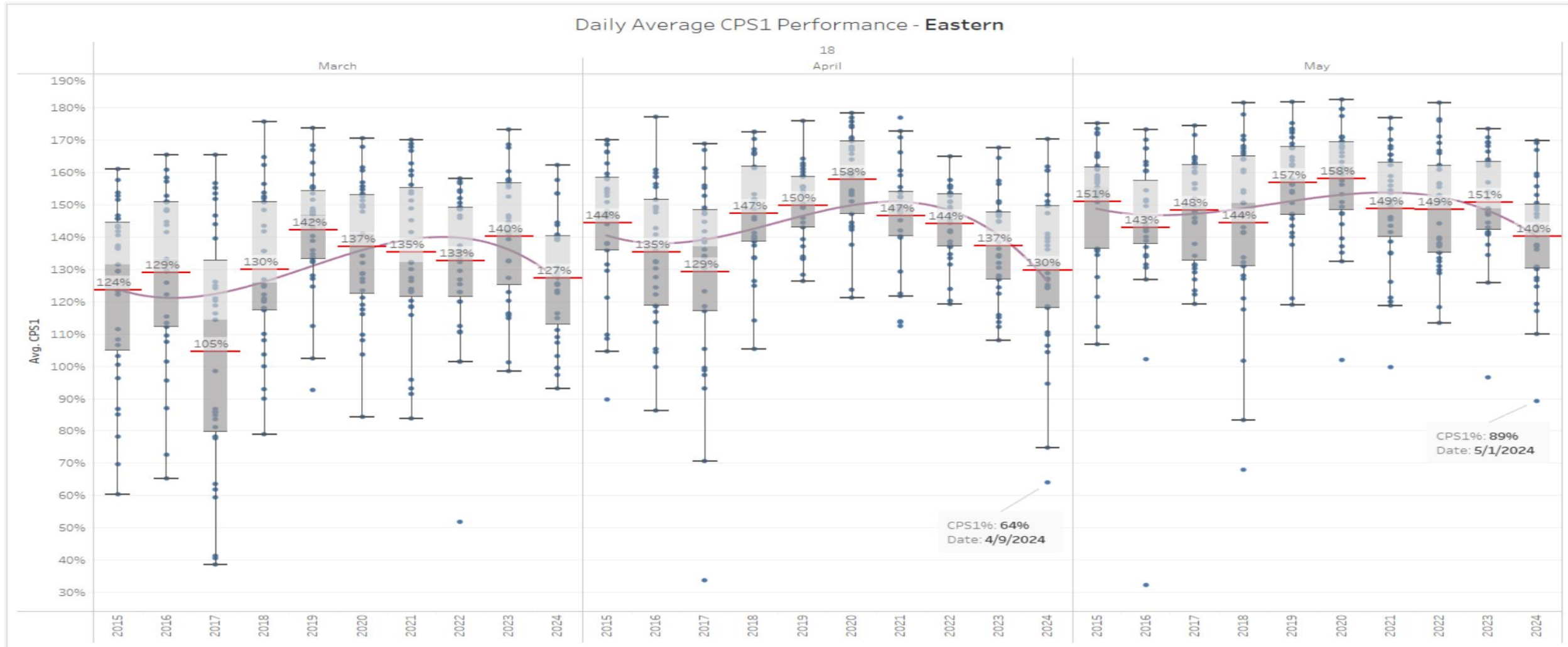
Impacts on the Eastern Interconnection



Impacts on the Eastern Interconnection



Impacts on the Eastern Interconnection

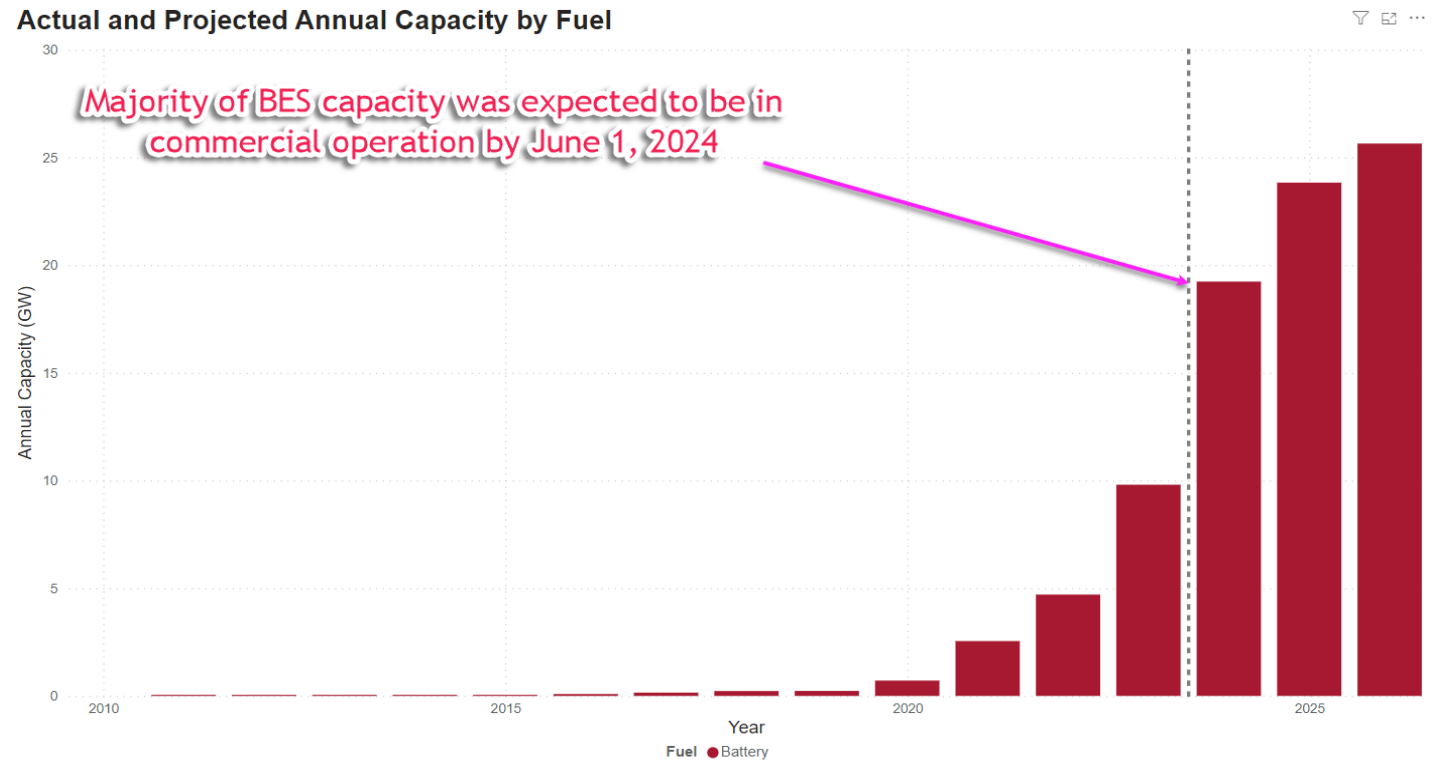


Big Machines Don't Change Directions Fast



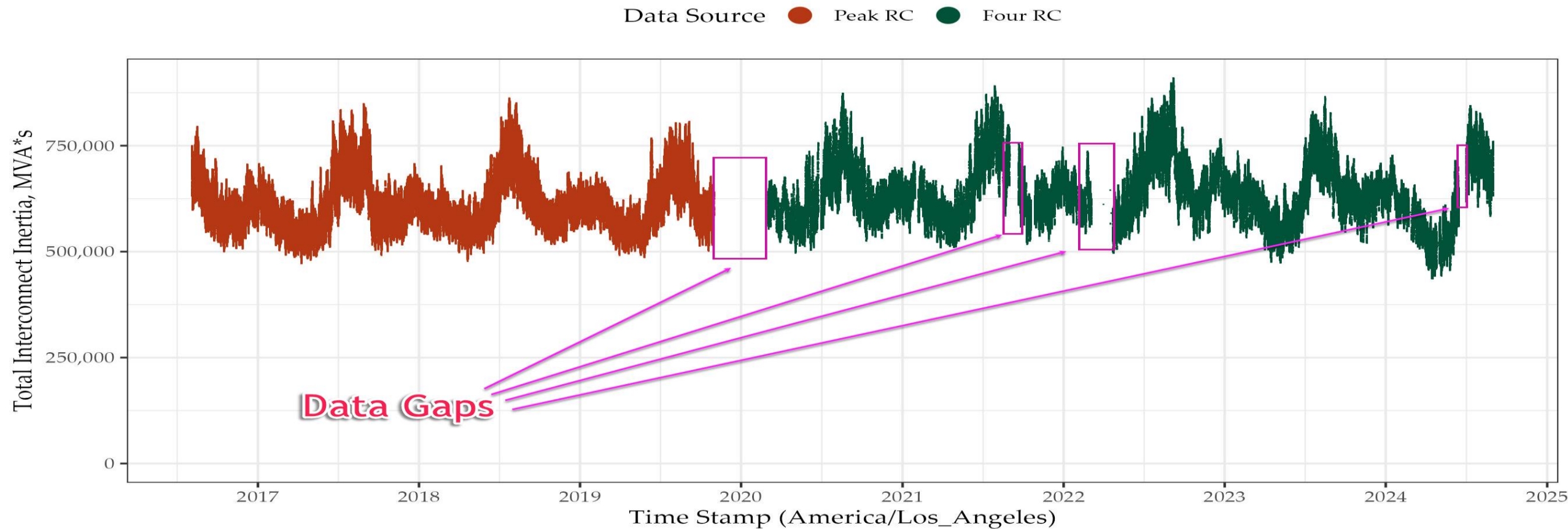
Next Steps

- Work with BAs with BES to determine more accurately how these systems are impacting (or not) interconnection frequency.
- BES installed capacity was ~9,800 MW on January 1, 2024, expected capacity by June 1, 2024 was over 19,000 MW.



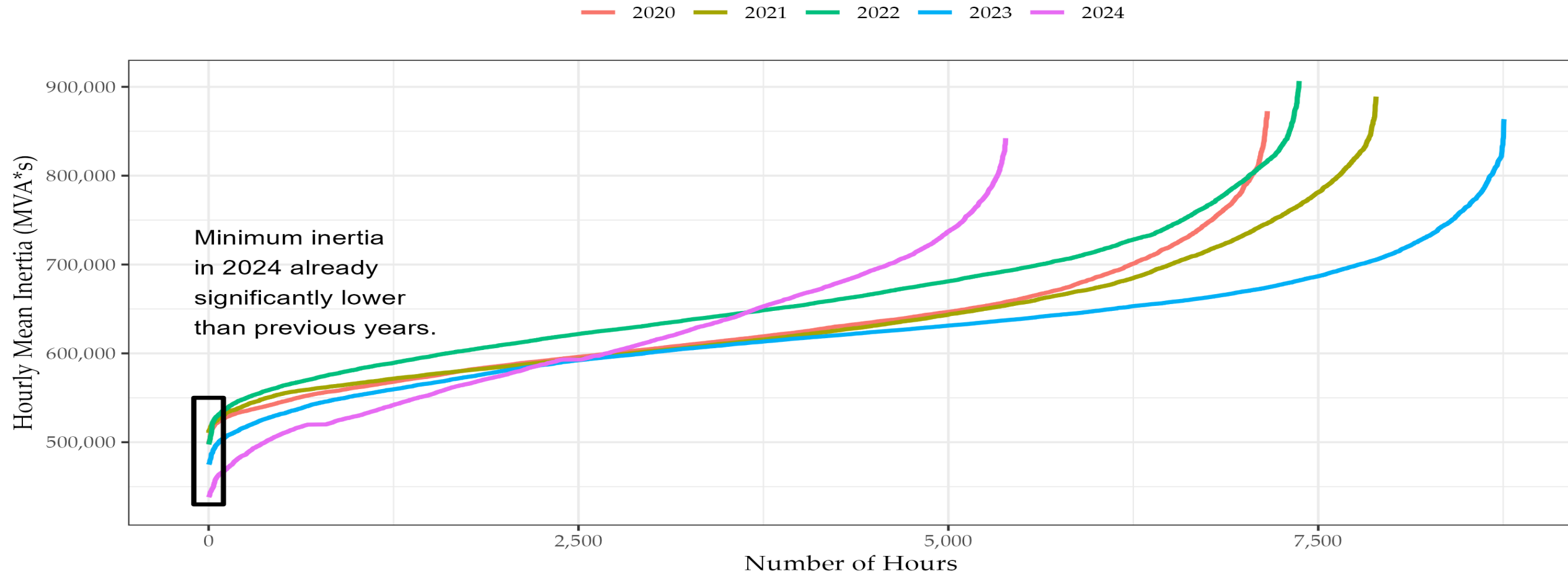
Other Impacts (Likely BES Penetration)

Western Interconnection System Inertia
(Hourly data, with obviously bad values removed.)



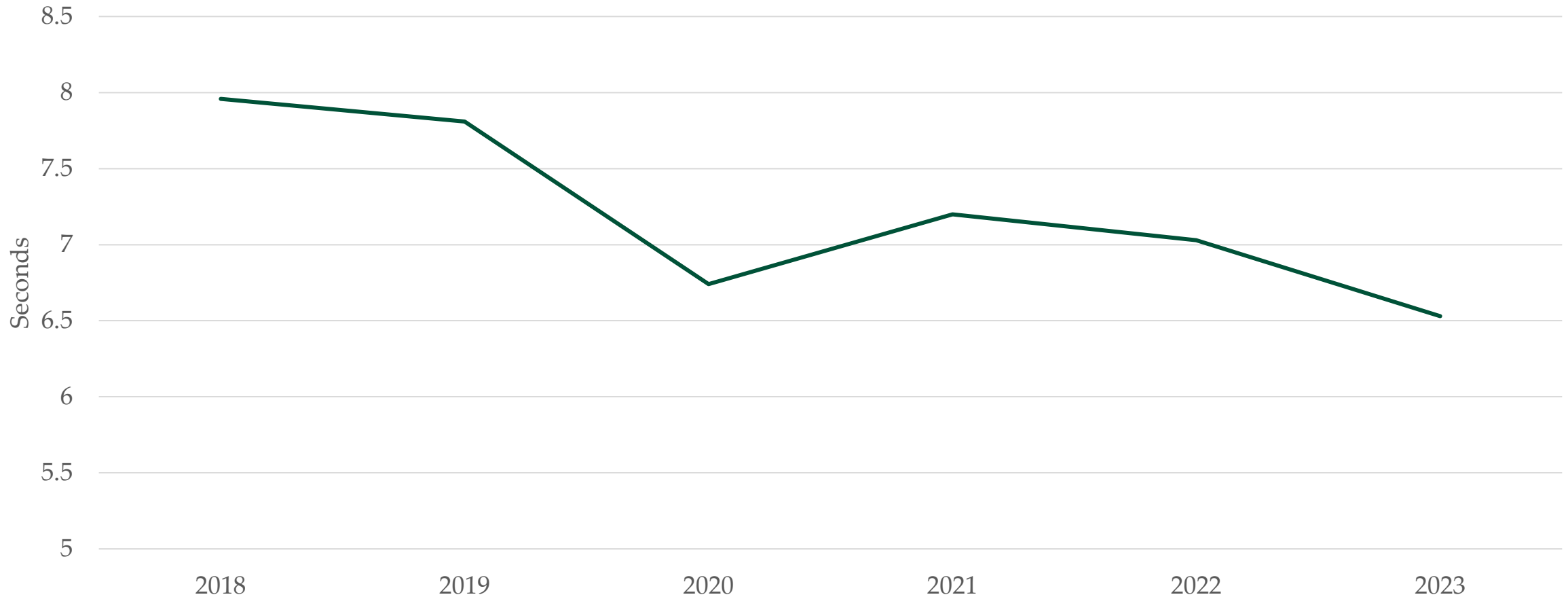
Other Impacts (Likely BES Penetration)

Cumulative Inertia Hour each Year
(Note that most years are incomplete.)



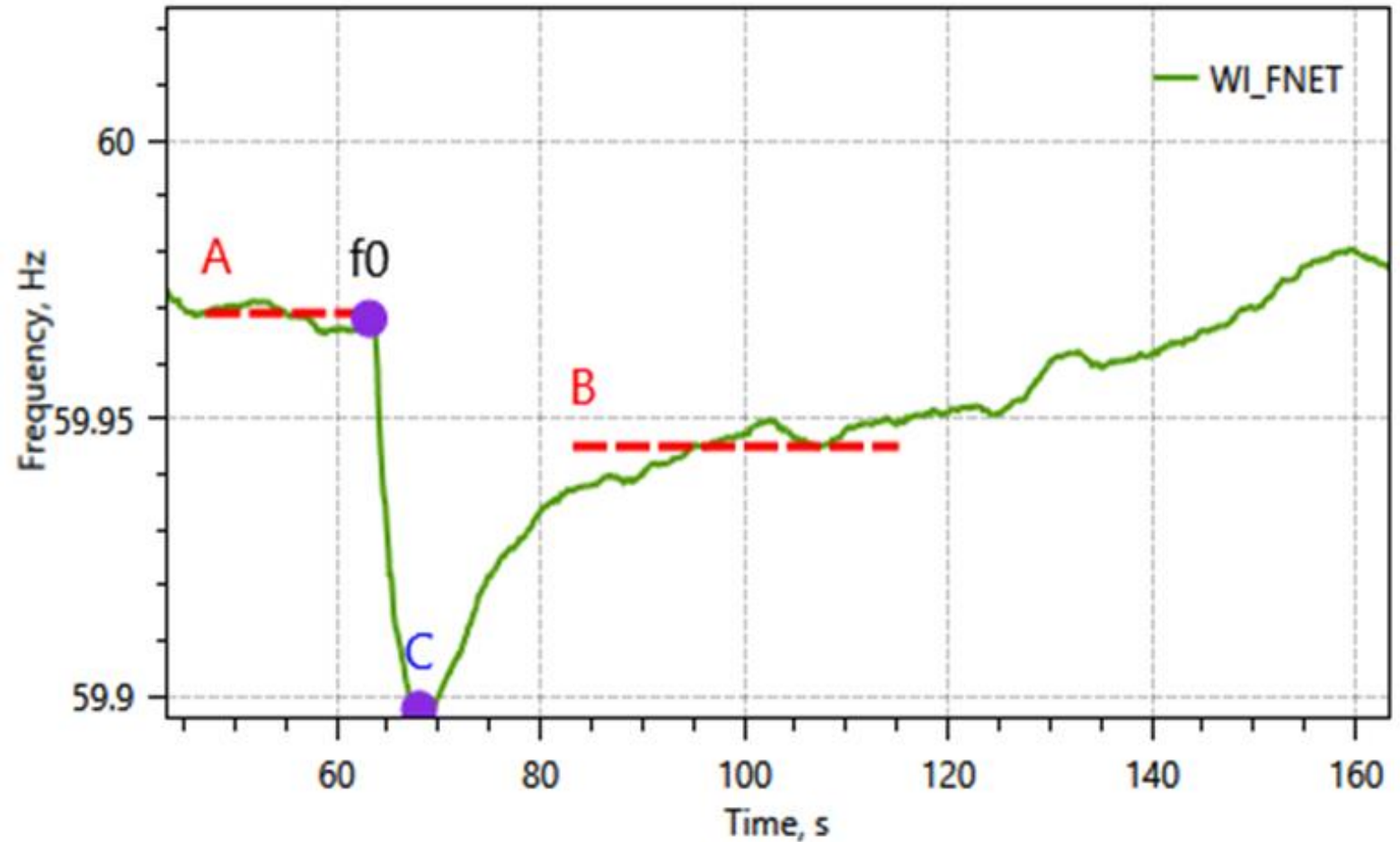
Other Impacts (Likely IBR Penetration)

Average Time from T0-TC by Year (Only events greater than 700 MW)



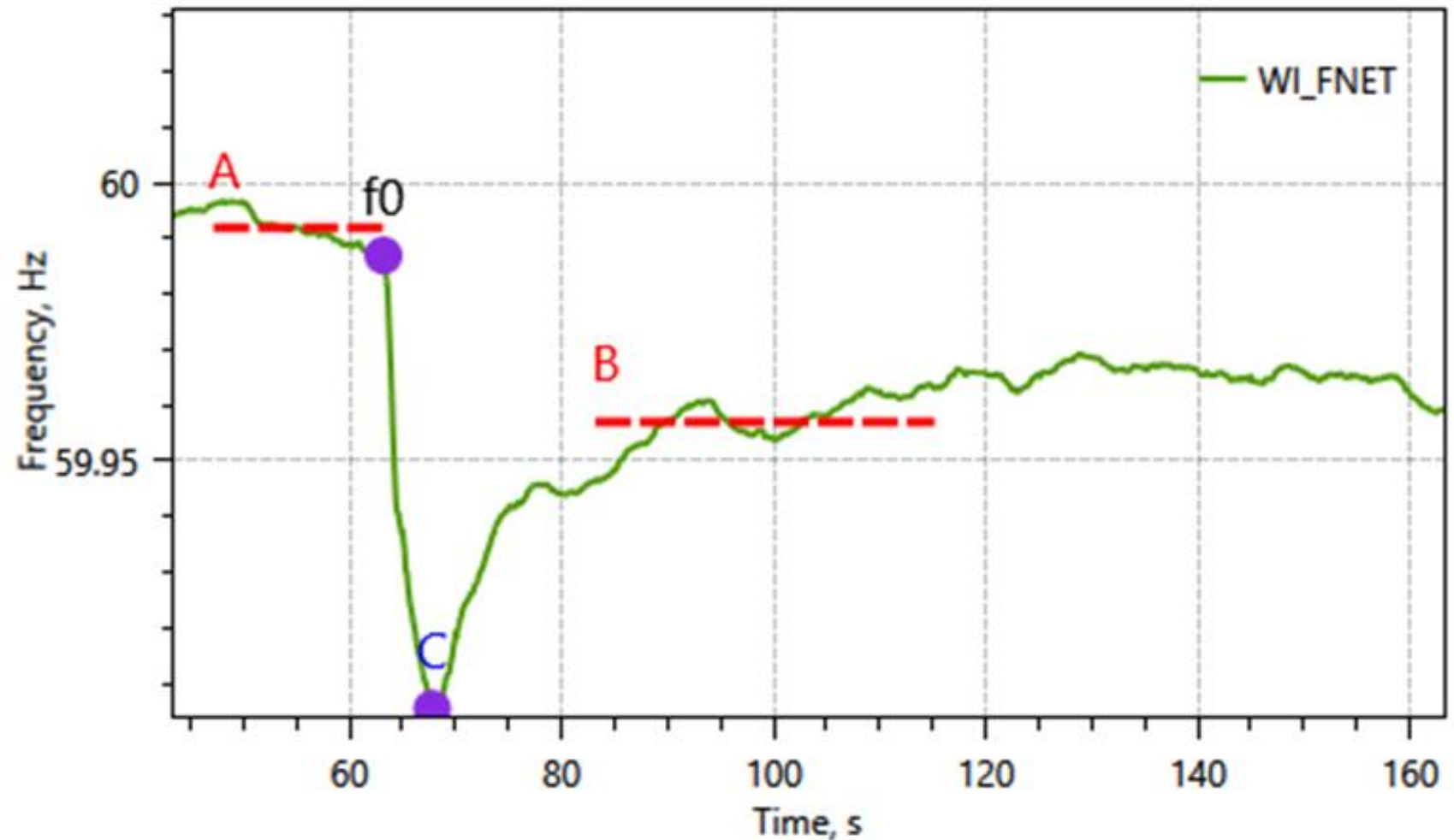
Other Impacts (Likely BES Penetration)

Event ID	WI_20240417_01 3417
UTC Time	04/17/2024 01:34:17
Local Time	04/16/2024 18:34:17
Time Zone	PDT
M4 Flag	Yes
BAL003 Flag	No
MW Loss	753
Value A	59.969
Value B	59.945
Point C	59.8977
Time of C	4.89999999999



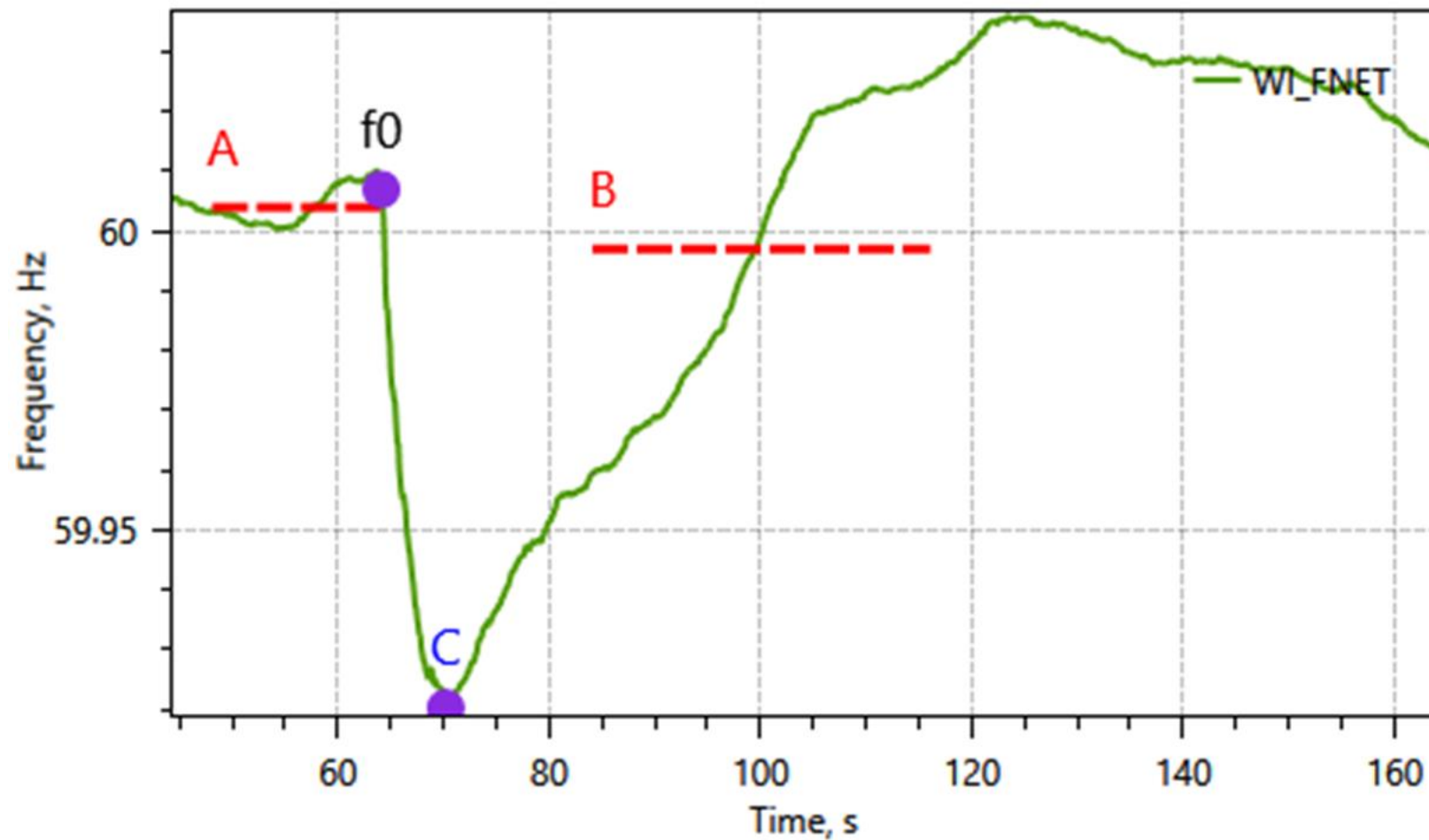
Other Impacts (Likely BES Penetration)

Event ID	WI_20240509_202321
UTC Time	05/09/2024 20:23:21
Local Time	05/09/2024 13:23:21
Time Zone	PDT
M4 Flag	Yes
BAL003 Flag	No
MW Loss	680
Value A	59.992
Value B	59.957
Point C	59.9054
Time of C	4.5999999999



Other Impacts (Likely BES Penetration)

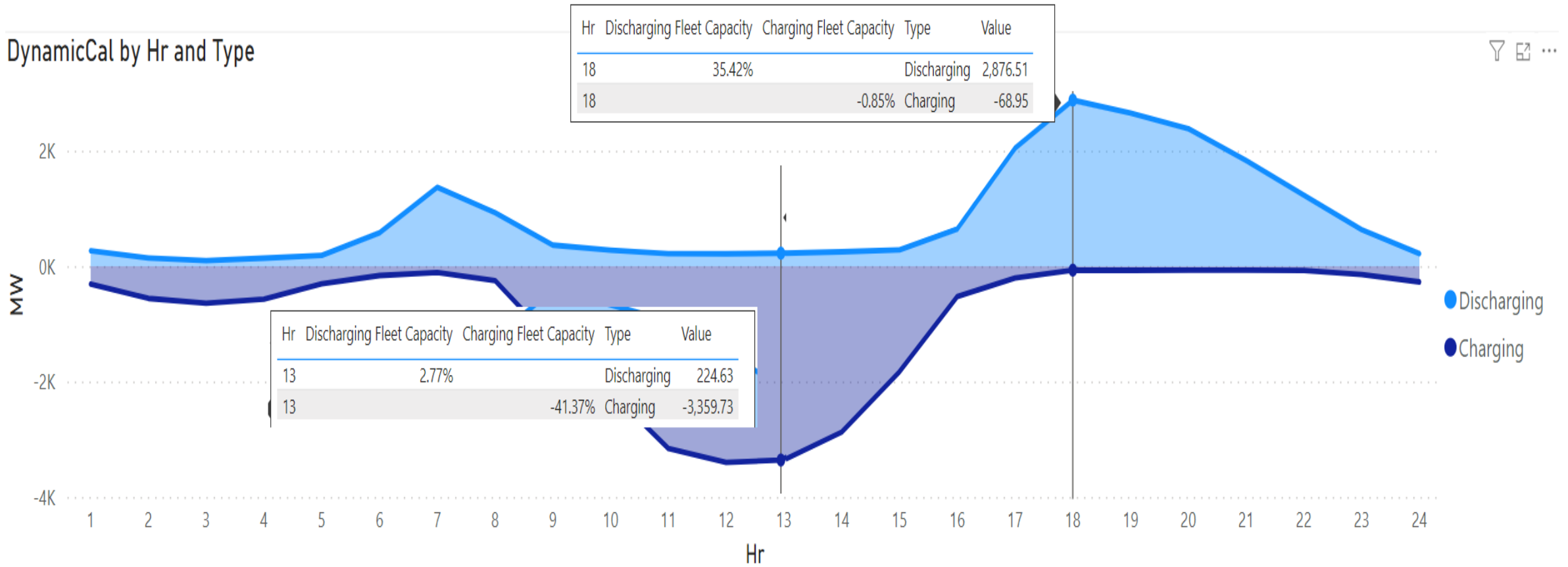
Event ID	WI_20240831_073650
UTC Time	08/31/2024 07:36:50
Local Time	08/31/2024 00:36:50
Time Zone	PDT
M4 Flag	Yes
BAL003 Flag	Yes
MW Loss	771
Value A	60.004
Value B	59.997
Point C	59.9202
Time of C	6.1



Western Interconnection Battery Usage (2023)

Daily Average by Hour for November

DynamicCal by Hr and Type



Next Steps

- WECC Performance Subcommittee (PS) will evaluate Primary Inadvertent data to determine which BA is the cause of the issue.
- WECC PS to work with the CAISO and SPP to determine impacts of energy imbalance markets and their impact during these times of low frequency and large interconnection ramps.

Next Steps

NERC Resources Subcommittee will continue to monitor EI and WI CPS1 performance and interconnection inertia to identify trends in frequency control and frequency response.

Next Steps

- WECC has received a State Estimator Snapshot from RC West for the hours in question.
- WECC is evaluating the project to build a transmission planning case with the load and unit dispatch from the hour in question.
- WECC can perform analysis to determine whether there is a reliability risk that is presenting itself during these periods of relatively low load and fast ramping of PV during solar ramp hours.



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