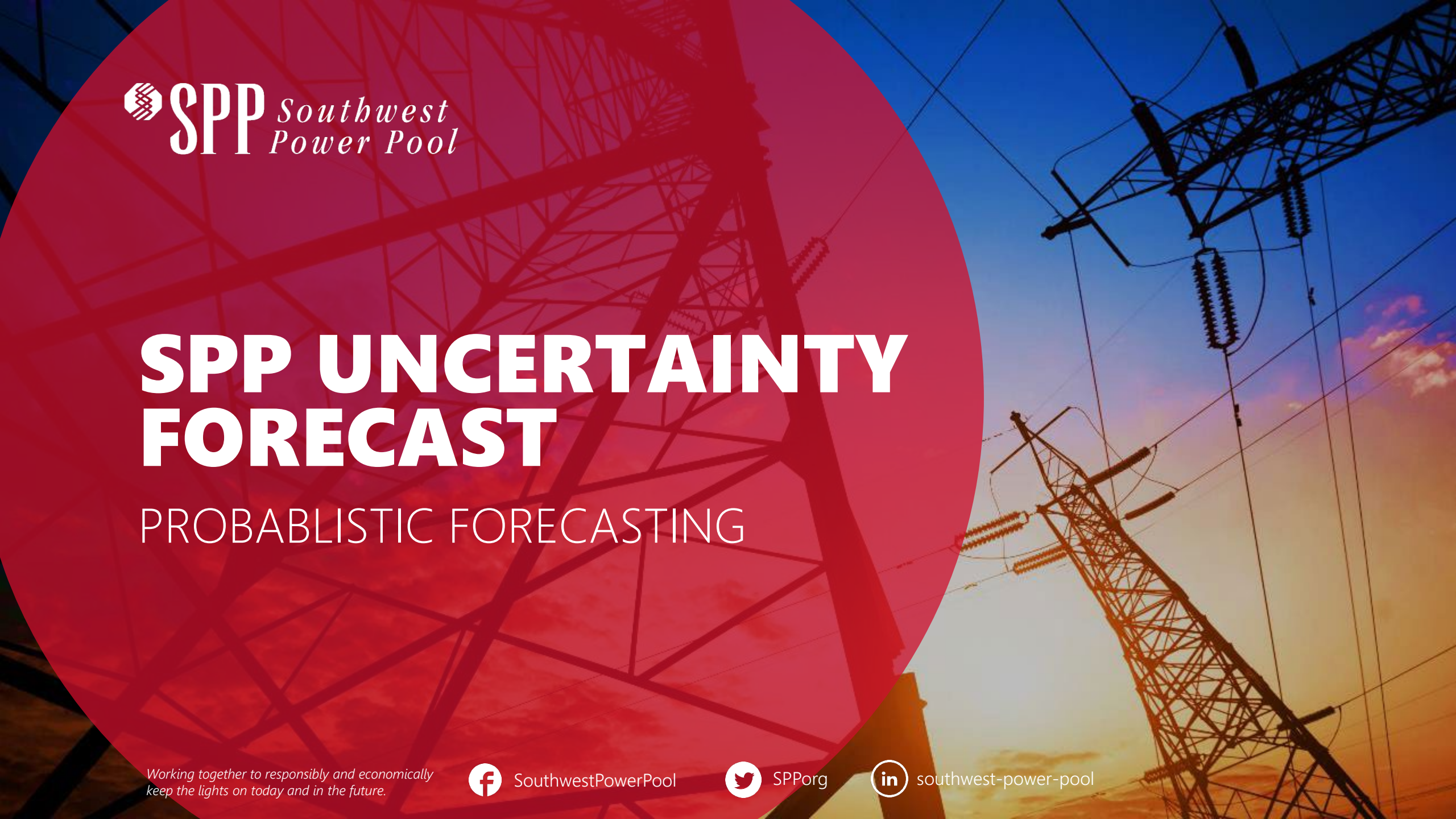


SPP Southwest Power Pool

SPP UNCERTAINTY FORECAST

PROBABLISTIC FORECASTING

Working together to responsibly and economically keep the lights on today and in the future.

SouthwestPowerPool SPPorg southwest-power-pool

UNCERTAINTY RESPONSE TEAM

OVERVIEW

SOURCES OF UNCERTAINTY

URT FUNCTIONS

URT serves to Detect, Evaluate, & Plan

Detect Potential Issues

- Daily evaluations flag uncertainty risks for the next 7 days
- Staff available on-call 24x7

Evaluate Risk

- Weather conditions
- Load levels
- Wind forecast
- Generator outages

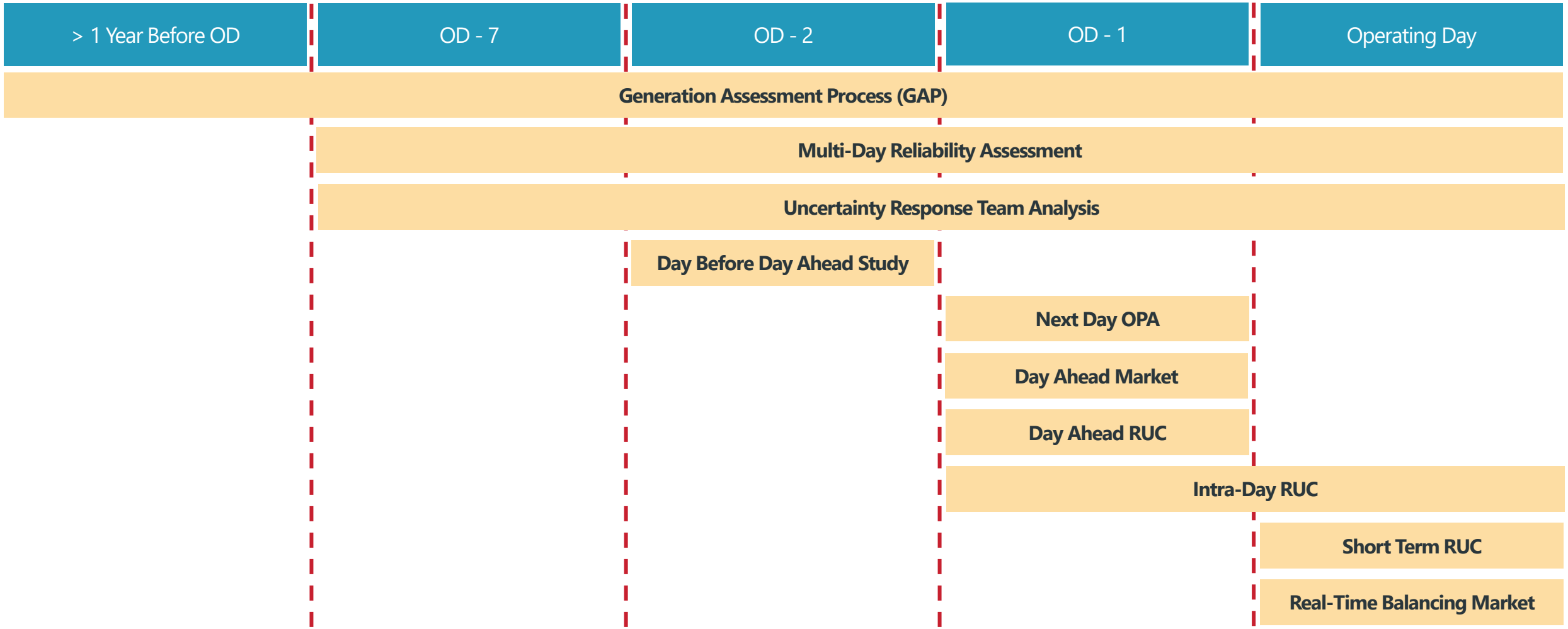
Develop Mitigation **Plans** in Advance

- Long-lead unit commitments
- System advisories
- Generator outage denials/reschedules

UNCERTAINTY EVALUATIONS

- Uncertainty capacity evaluations performed for next 7 days
- Assessment done on all horizons
- Uncertainty factors: load, wind, & resource error
- Uncertainty error applied to available online/offline capacity over each horizon

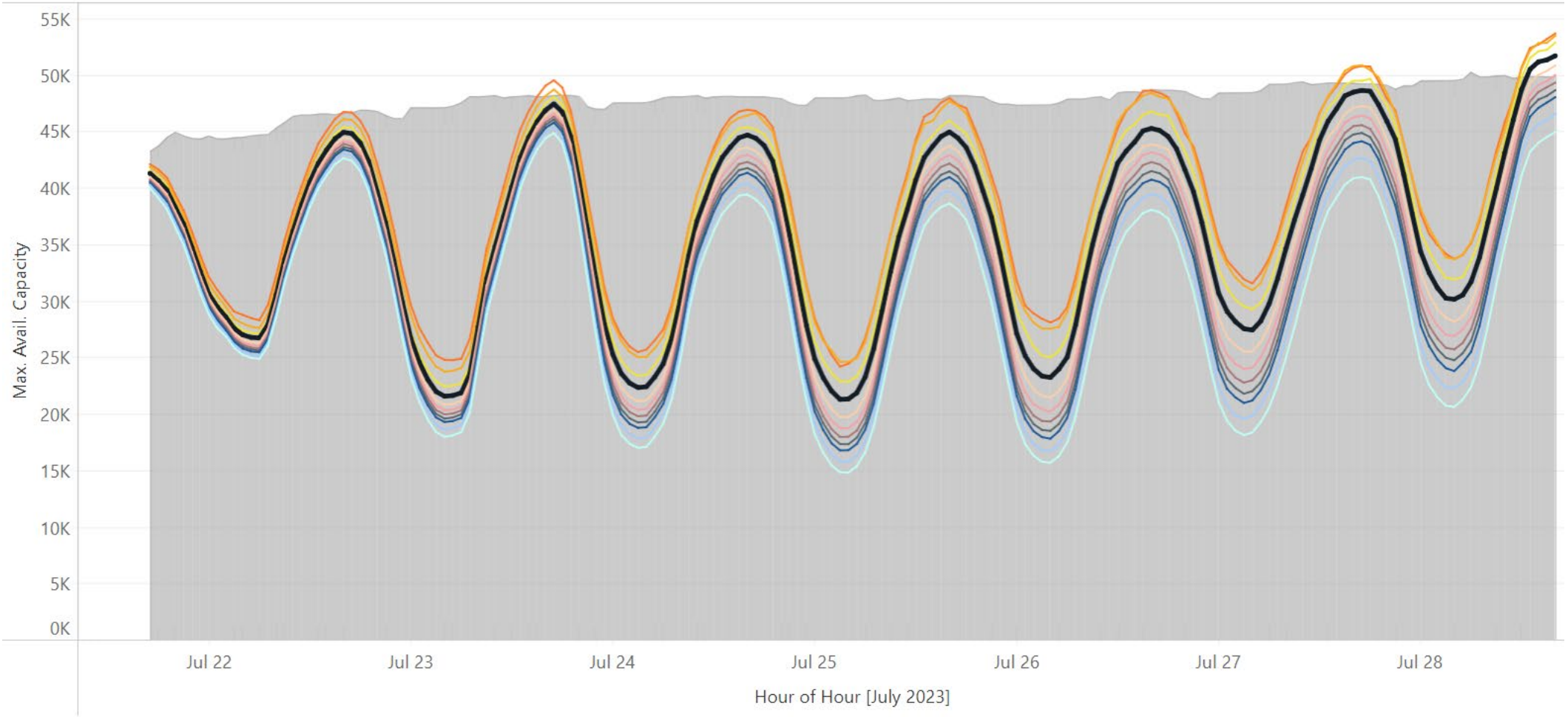
OPERATIONAL STUDIES & ANALYSIS



*Timeline represents when studies or analysis are performed relative to the Operating Day

CAPACITY VS NET LOAD UNCERTAINTY

Capacity vs Uncertainty
Run Time: **7/21/2023 4:00:00 PM**

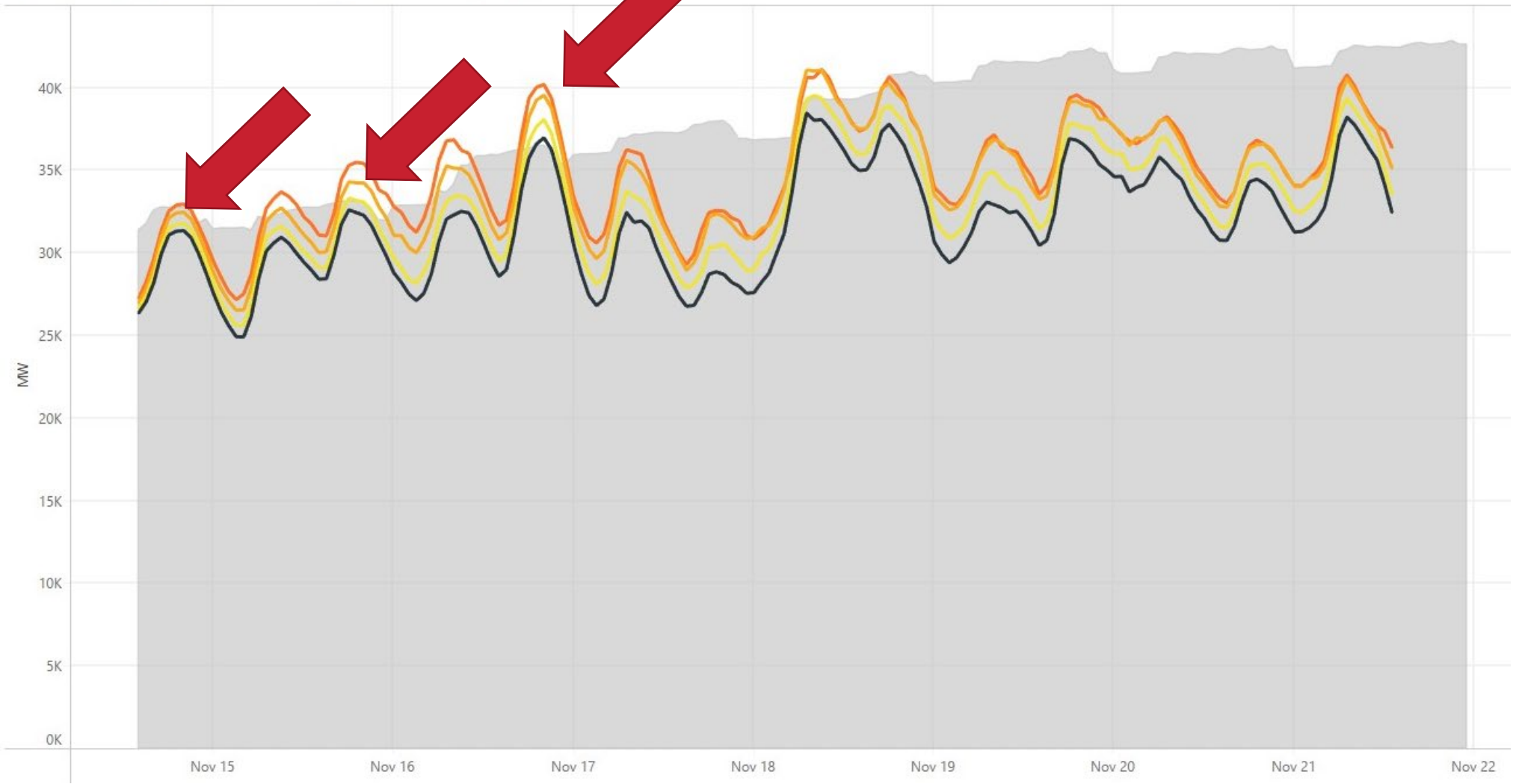


Available Capacity vs Uncertainty - 11/14/2022 1:00:00 PM

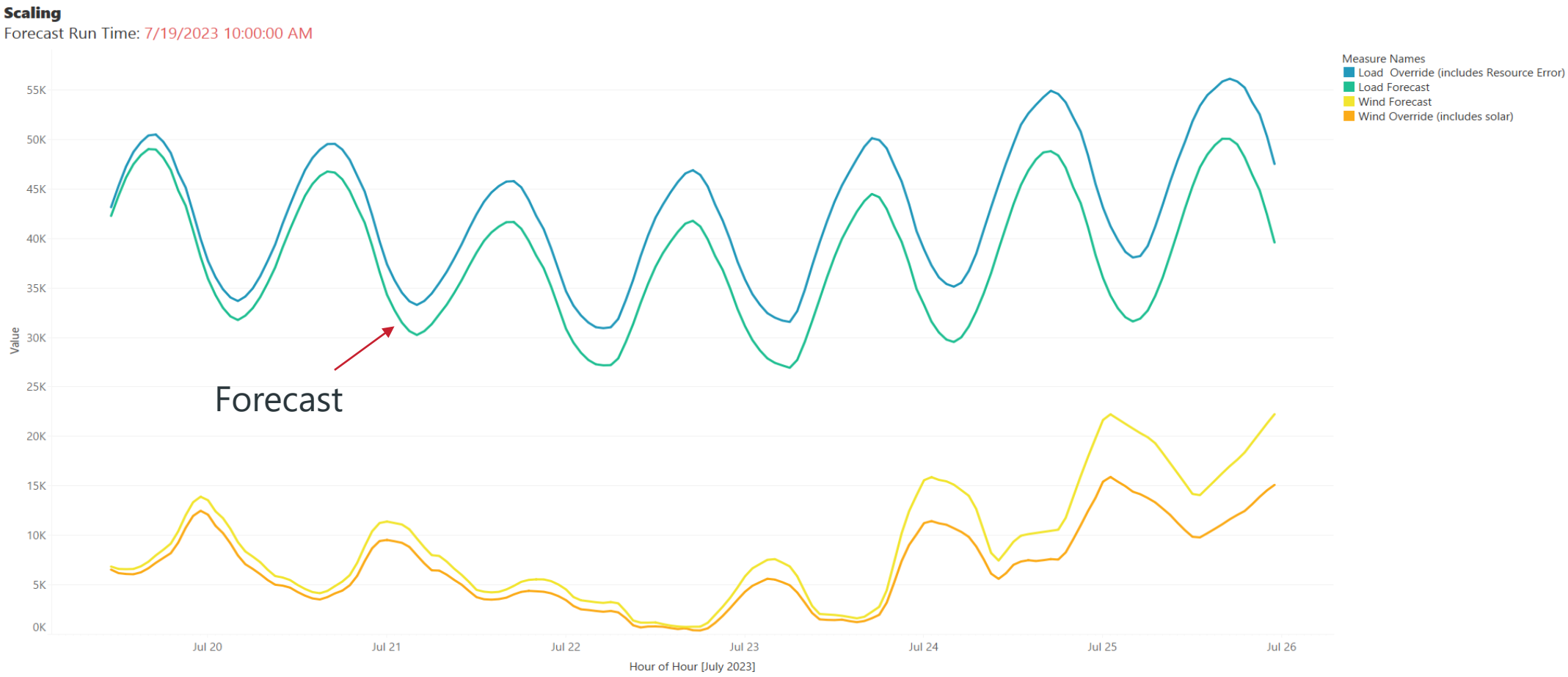
Load Risk: RiskType=2 - by Forecasted Temperature

Outage Risk: RiskType=6 - by Forecasted Temperature - No WWE

Wind Risk: RiskType=1 - (Normal-only) by Forecasted Capacity Factor



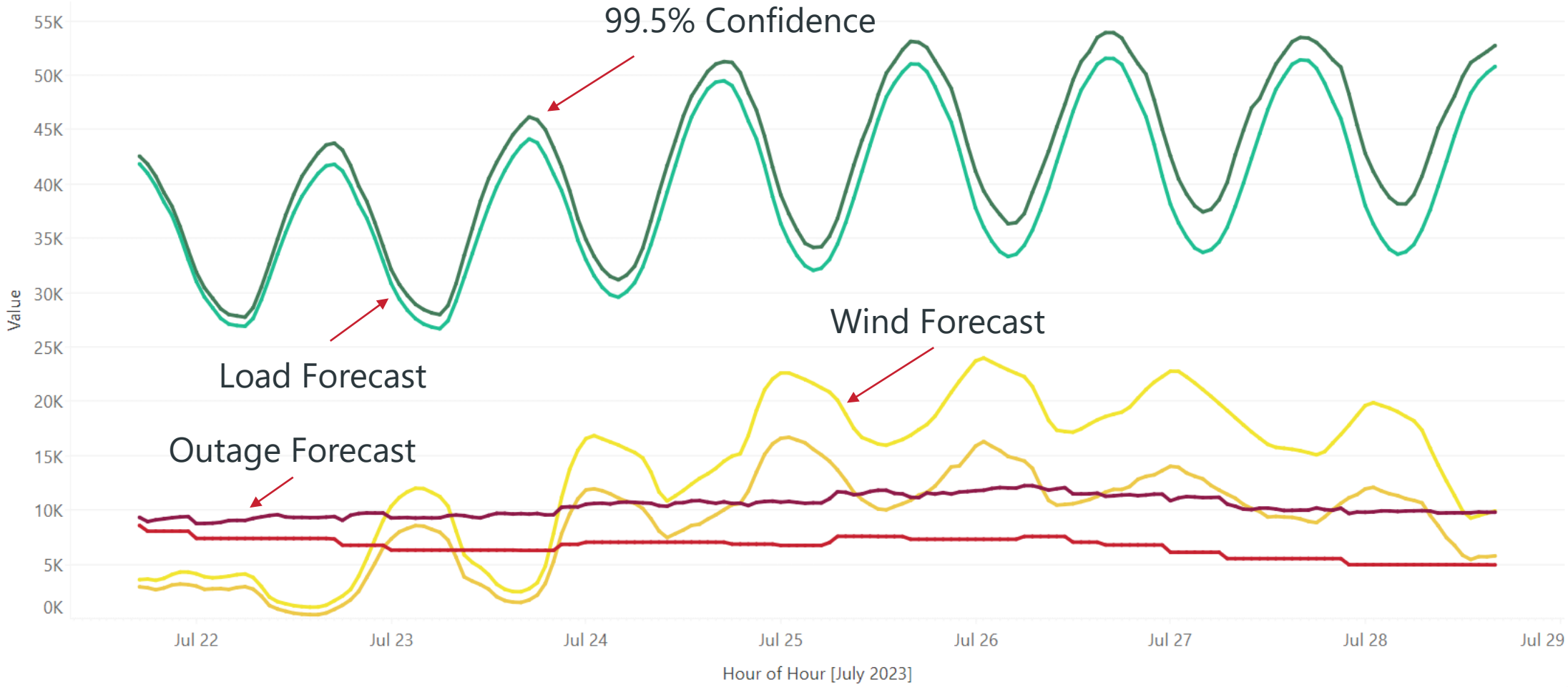
SCALED LOAD & WIND FORECASTS



ERROR FORECAST BY CONFIDENCE INTERVAL

Error Trends

Forecast Run Time: 7/21/2023 4:00:00 PM



HIGH RISK SCENARIO REPORT

Horizon Based Capacity Utilization (Market Only w/Reserves):

Percentile	Fri, Jan-12-2024	Sat, Jan-13-2024	Sun, Jan-14-2024	Mon, Jan-15-2024	Tue, Jan-16-2024	Wed, Jan-17-2024	Thu, Jan-18-2024
50th	0.71	0.79	0.95	1	0.99	0.71	0.7
75th	0.74	0.84	1.01	1.07	1.08	0.77	0.77
80th	0.74	0.86	1.02	1.08	1.1	0.78	0.8
85th	0.75	0.87	1.02	1.09	1.12	0.79	0.82
90th	0.76	0.89	1.04	1.1	1.14	0.82	0.84
95th	0.77	0.91	1.07	1.14	1.15	0.91	0.93
97.5th	0.78	0.93	1.1	1.17	1.18	0.95	0.98
99th	0.8	0.98	1.13	1.19	1.21	0.97	1.01
99.5th	0.83	1	1.14	1.18	1.2	0.97	1.01
99.97th	0.85	0.98	1.11	1.18	1.18	0.92	1.02

Horizon Based Capacity Utilization (Reliability Included w/Reserves) :

Percentile	Fri, Jan-12-2024	Sat, Jan-13-2024	Sun, Jan-14-2024	Mon, Jan-15-2024	Tue, Jan-16-2024	Wed, Jan-17-2024	Thu, Jan-18-2024
50th	0.7	0.77	0.9	0.95	0.94	0.68	0.67
75th	0.72	0.81	0.96	1.02	1.04	0.74	0.74
80th	0.73	0.83	0.97	1.03	1.05	0.75	0.77
85th	0.73	0.84	0.98	1.04	1.07	0.77	0.78
90th	0.74	0.85	0.99	1.05	1.09	0.79	0.81
95th	0.76	0.88	1.02	1.09	1.1	0.88	0.89
97.5th	0.77	0.89	1.05	1.12	1.13	0.91	0.93
99th	0.79	0.94	1.08	1.14	1.16	0.94	0.97
99.5th	0.81	0.96	1.09	1.12	1.15	0.94	0.96
99.97th	0.84	0.95	1.06	1.13	1.13	0.89	0.98

URT PROCESS

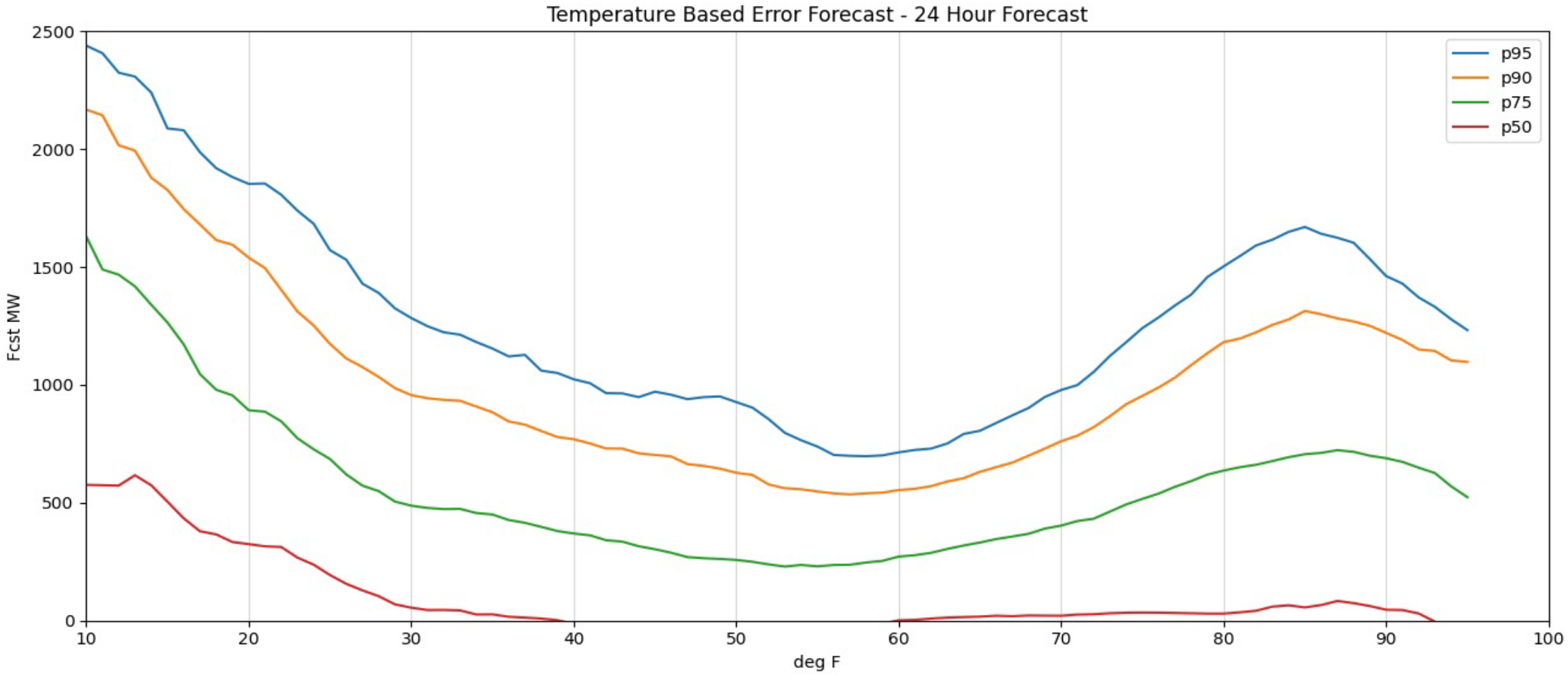
ERROR FORECASTING

TEMPERATURE FORECAST

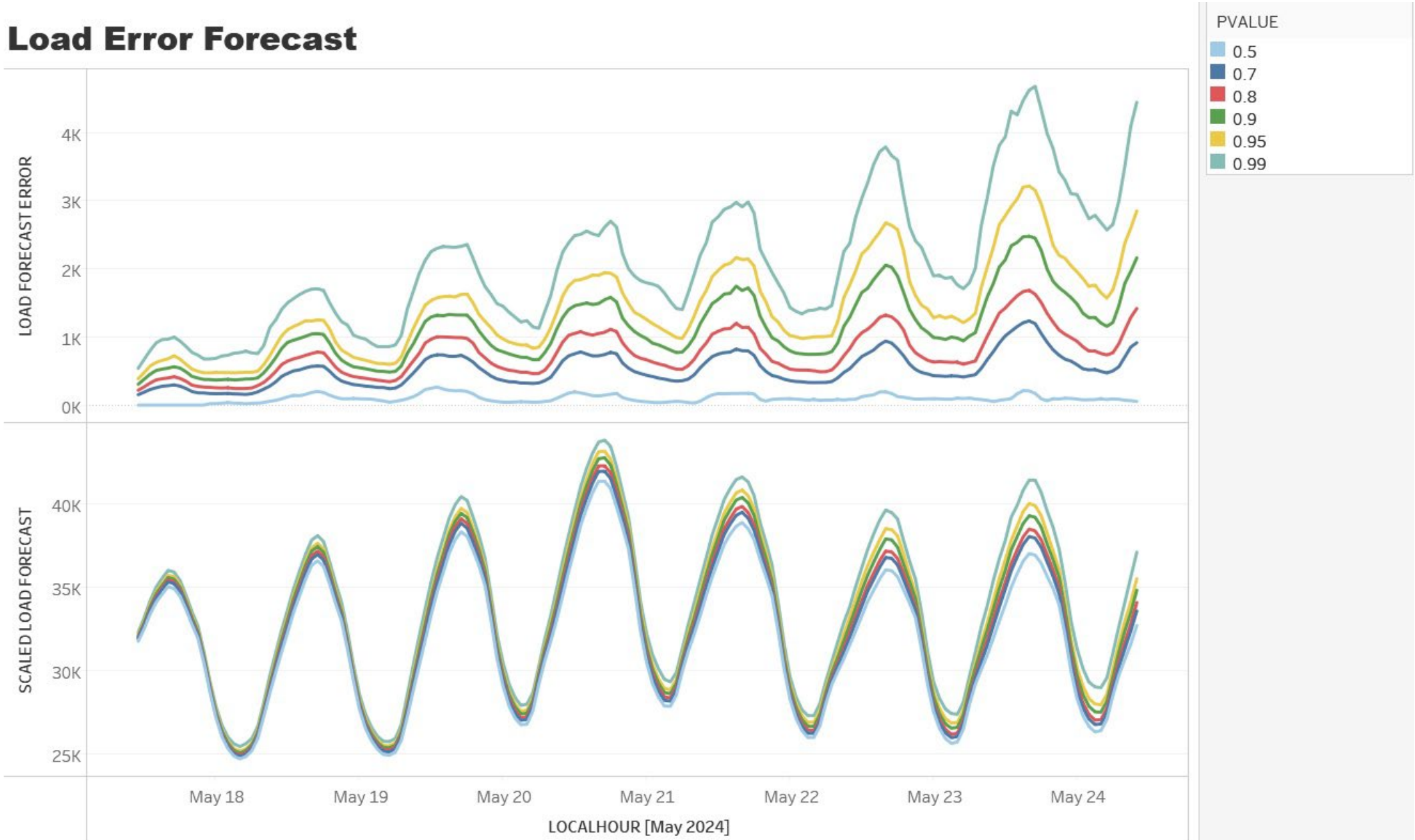
Temperature Assessment:

Region	City	Fri, Jul-21-2023	Sat, Jul-22-2023	Sun, Jul-23-2023	Mon, Jul-24-2023	Tue, Jul-25-2023	Wed, Jul-26-2023	Thu, Jul-27-2023
North	Aberdeen, SD	85/56	90/58	93/59	96/65	96/68	99/67	95/67
	Jamestown, ND	82/56	86/60	88/60	90/62	90/67	90/67	88/64
	Rapid City, SD	82/52	88/61	95/66	95/69	95/71	94/67	92/68
	Sioux Falls, SD	83/59	88/60	90/62	94/67	95/71	98/71	95/71
	Williston, ND	85/55	88/58	96/62	95/63	96/68	90/63	86/61
Central	Dodge City, KS	76/63	85/60	93/64	96/69	97/73	97/73	96/73
	Hays, KS	79/62	87/61	92/64	95/69	97/72	96/72	96/72
	Kansas City, MO	81/67	84/62	87/65	92/69	96/73	98/77	98/79
	Lincoln, NE	84/63	87/64	92/64	96/70	98/74	98/76	98/74
	Manhattan, KS	84/66	89/63	93/65	98/70	101/75	102/78	103/78
	North Platte, NE	82/57	90/61	95/62	98/68	100/71	98/70	97/69
	Omaha, NE	83/62	87/64	91/64	96/68	98/73	99/76	97/75
	Springfield, MO	87/70	85/60	86/64	92/67	95/70	96/73	96/74
	Wichita, KS	87/66	85/63	89/66	92/69	94/72	95/76	95/75
South	Amarillo,TX	90/66	88/61	96/65	99/70	101/74	99/74	98/72
	Fort Smith, AR	93/81	88/68	91/67	95/70	97/72	98/74	97/74
	Lawton, OK	91/74	90/66	96/65	102/70	104/75	103/77	102/76
	Lubbock, TX	96/72	91/66	98/68	101/72	102/75	101/74	99/73
	Mc Alester, OK	90/76	85/67	90/66	94/71	97/75	96/76	95/76
	Oklahoma City, OK	88/74	85/63	90/66	96/69	99/74	98/77	98/76
	Shreveport, LA	99/78	92/78	93/73	96/74	97/76	97/77	96/78
	Tulsa, OK	89/71	86/64	91/68	95/71	98/74	98/77	98/78

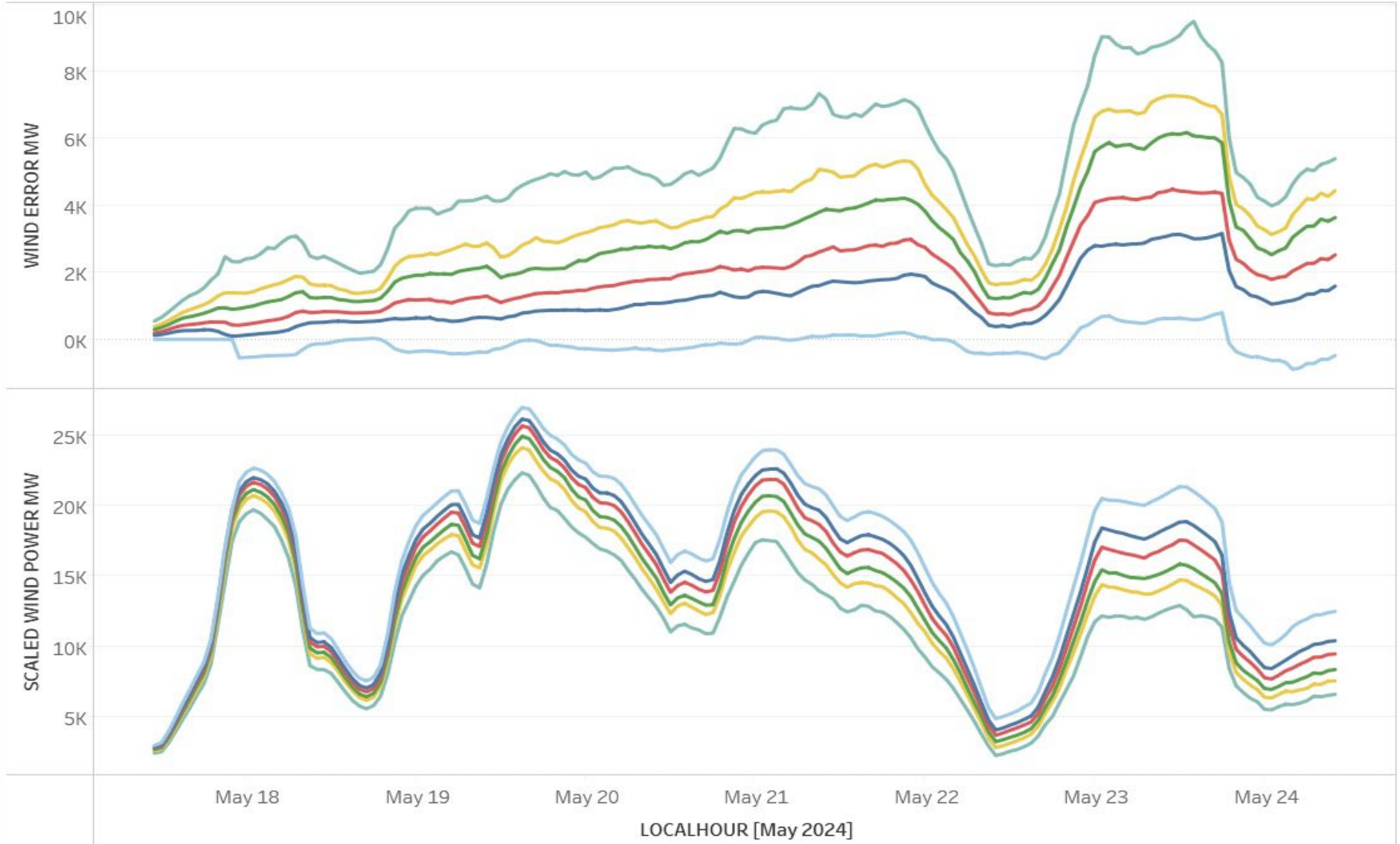
TEMPERATURE AND ERROR FORECAST



Load Error Forecast

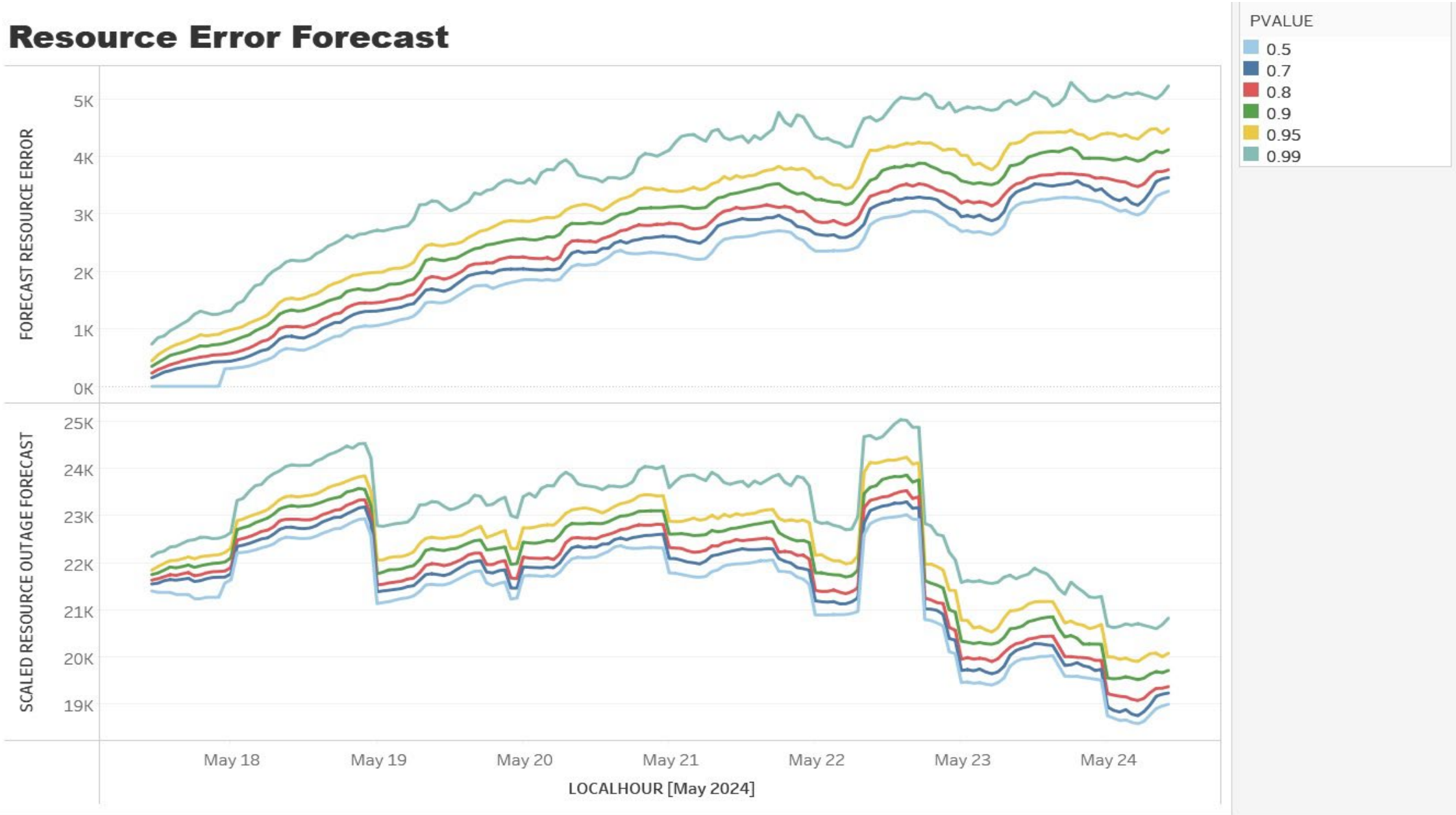


Wind Error Forecast



PVALUE
- 0.5
- 0.7
- 0.8
- 0.9
- 0.95
- 0.99

Resource Error Forecast

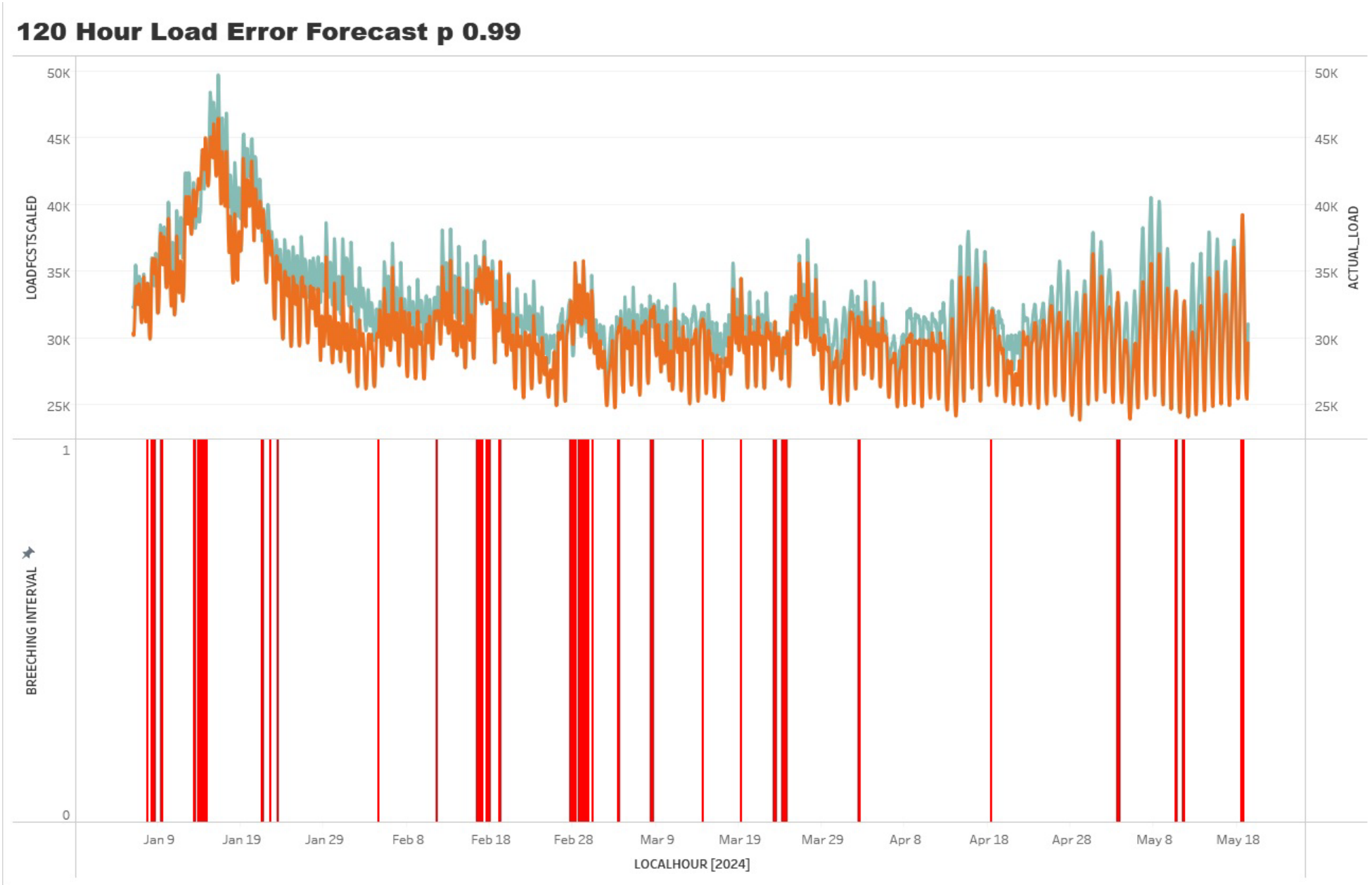


Coincident Net Error Forecast

VERIFICATION EXAMPLE

ERROR FORECASTING

120 Hour Load Error Forecast p 0.99



RUNTIME

1/1/2024 7:00:00 5/19/2024 4:00:0

PVALUE

0.99

Horizon

120

0

1

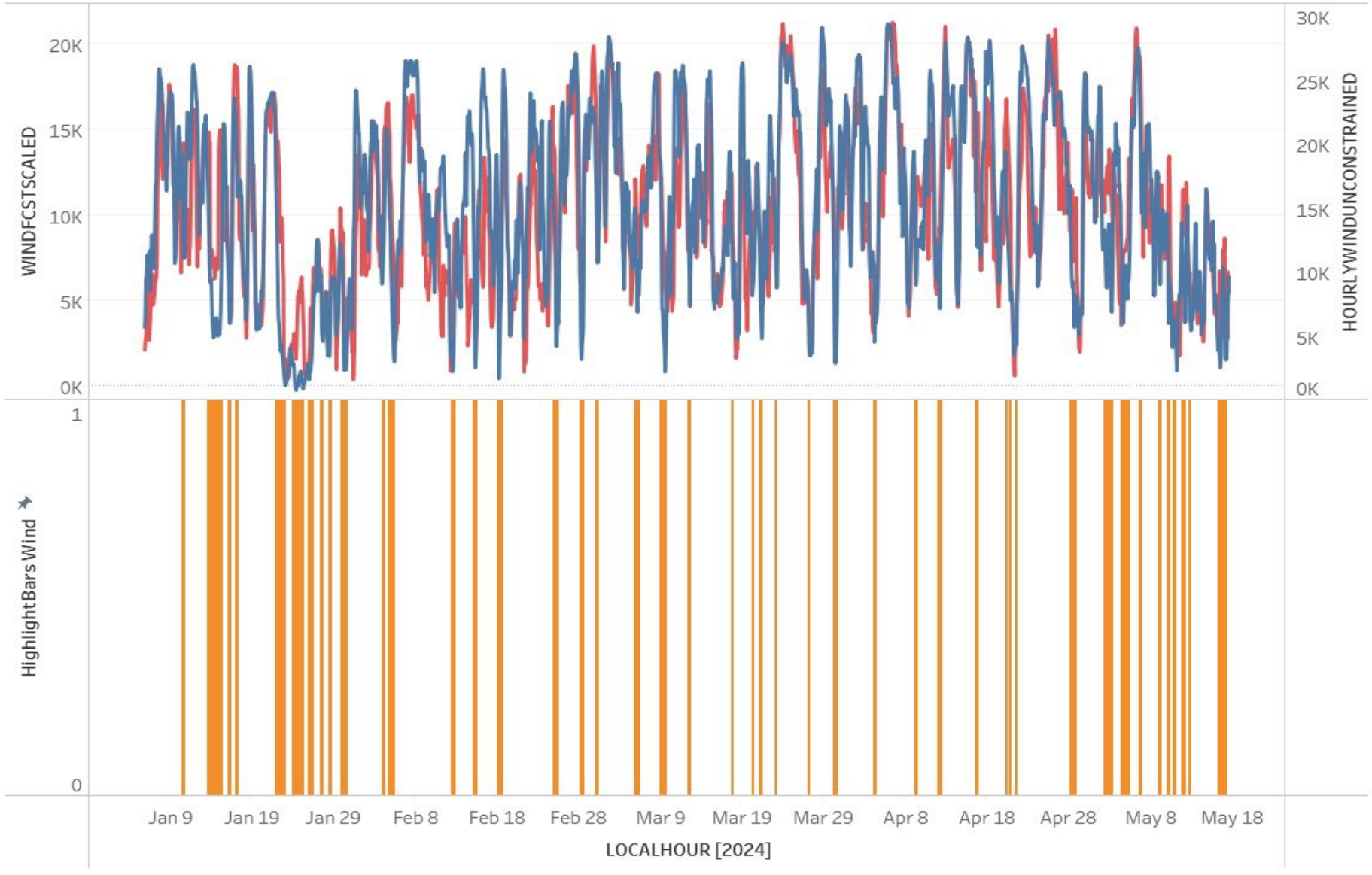
FORECAST PVALUE

0.99

Measure Names

ACTUAL_LOAD

120 Hour Wind Error at 0.99 confidence



MKTHOUR (Custom SQL Quer...

1/2/2024 7:00:00 A 5/17/2024 11:59:5

Horizon

120

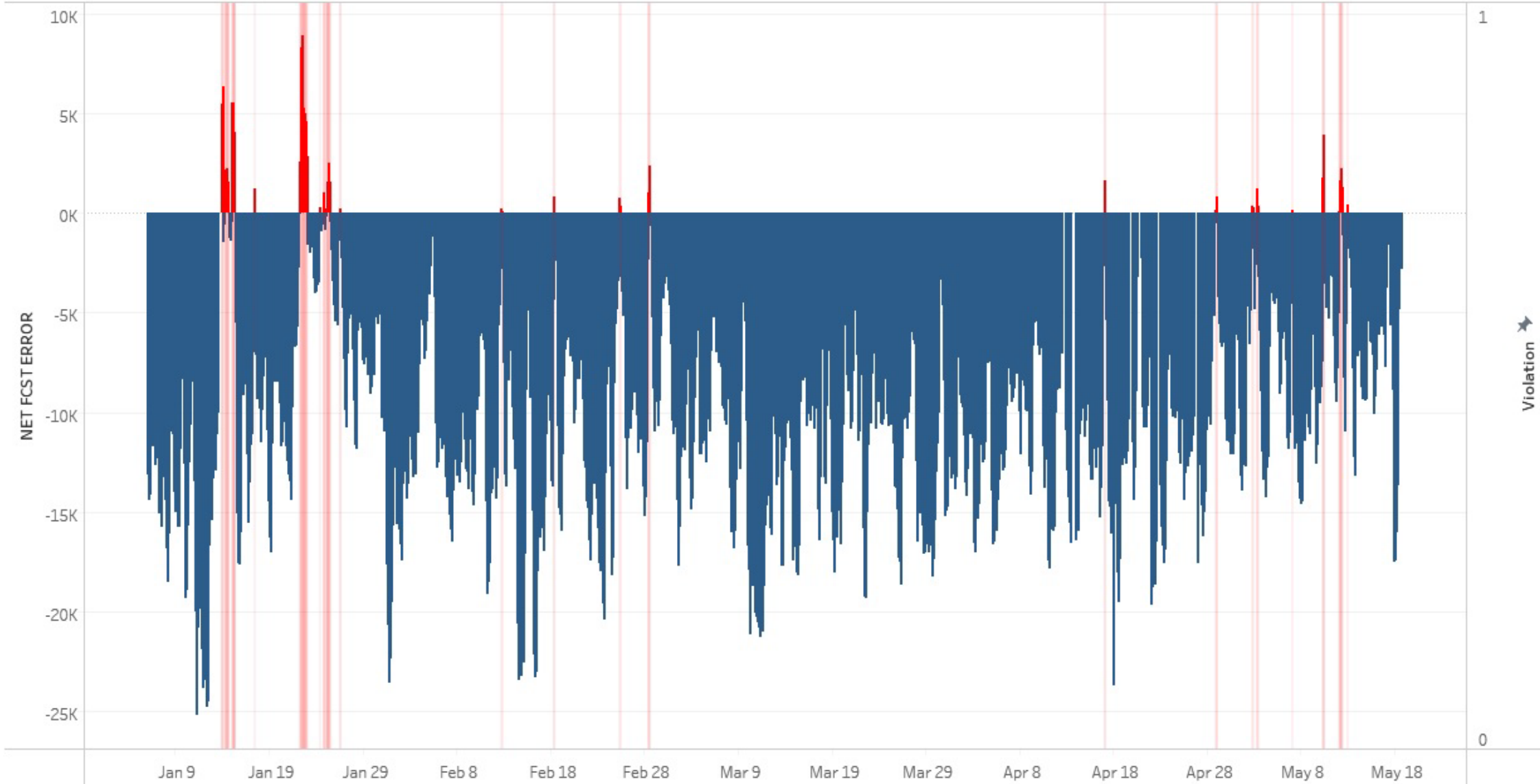
PVALUE

0.99

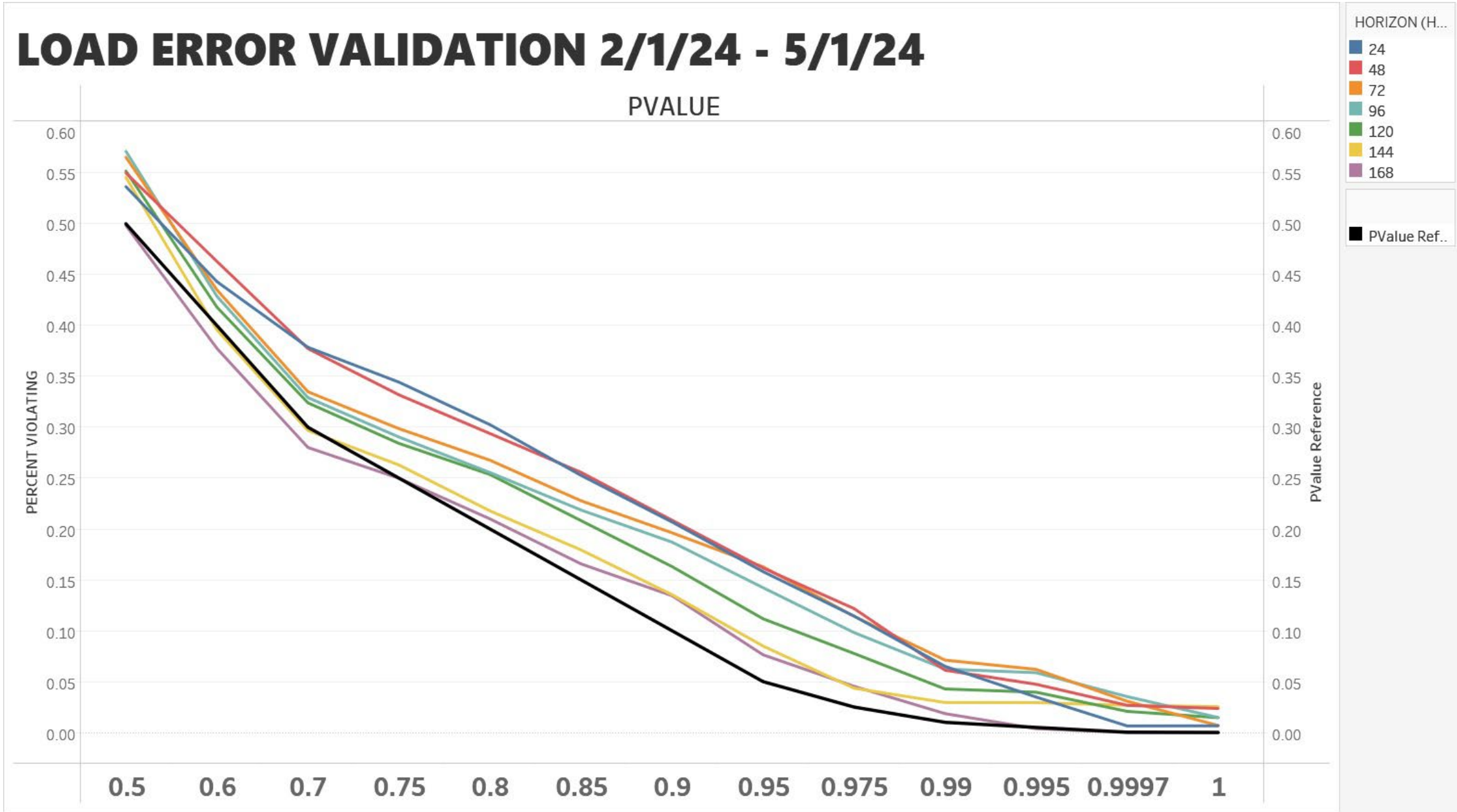
PVALUE, Measure Names

- 0.99, ACTUAL WIND
- 0.99, SCALED WIND FCST
- 0.99, VIOLATION

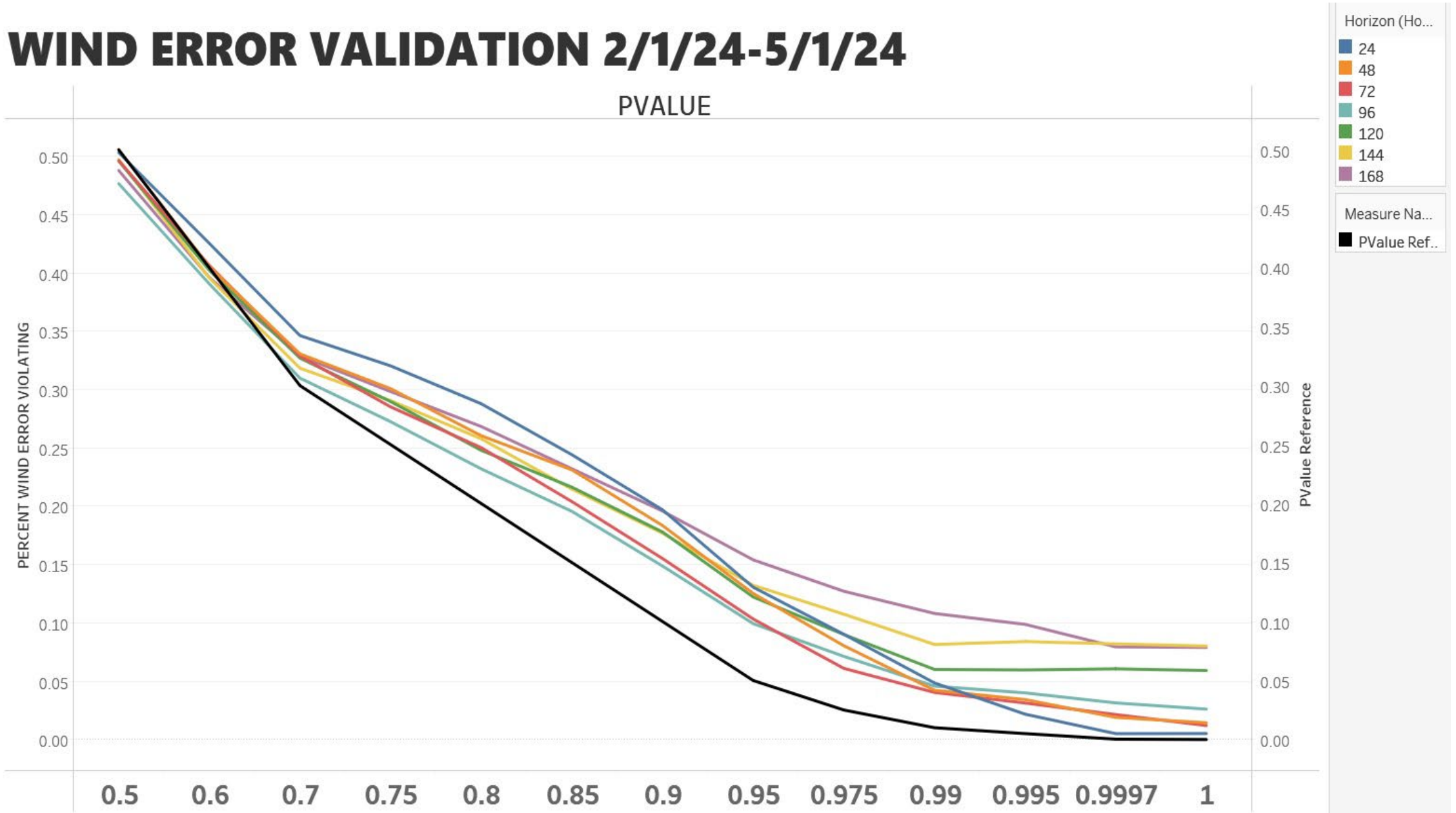
120 HOUR NET ERROR p 0.99



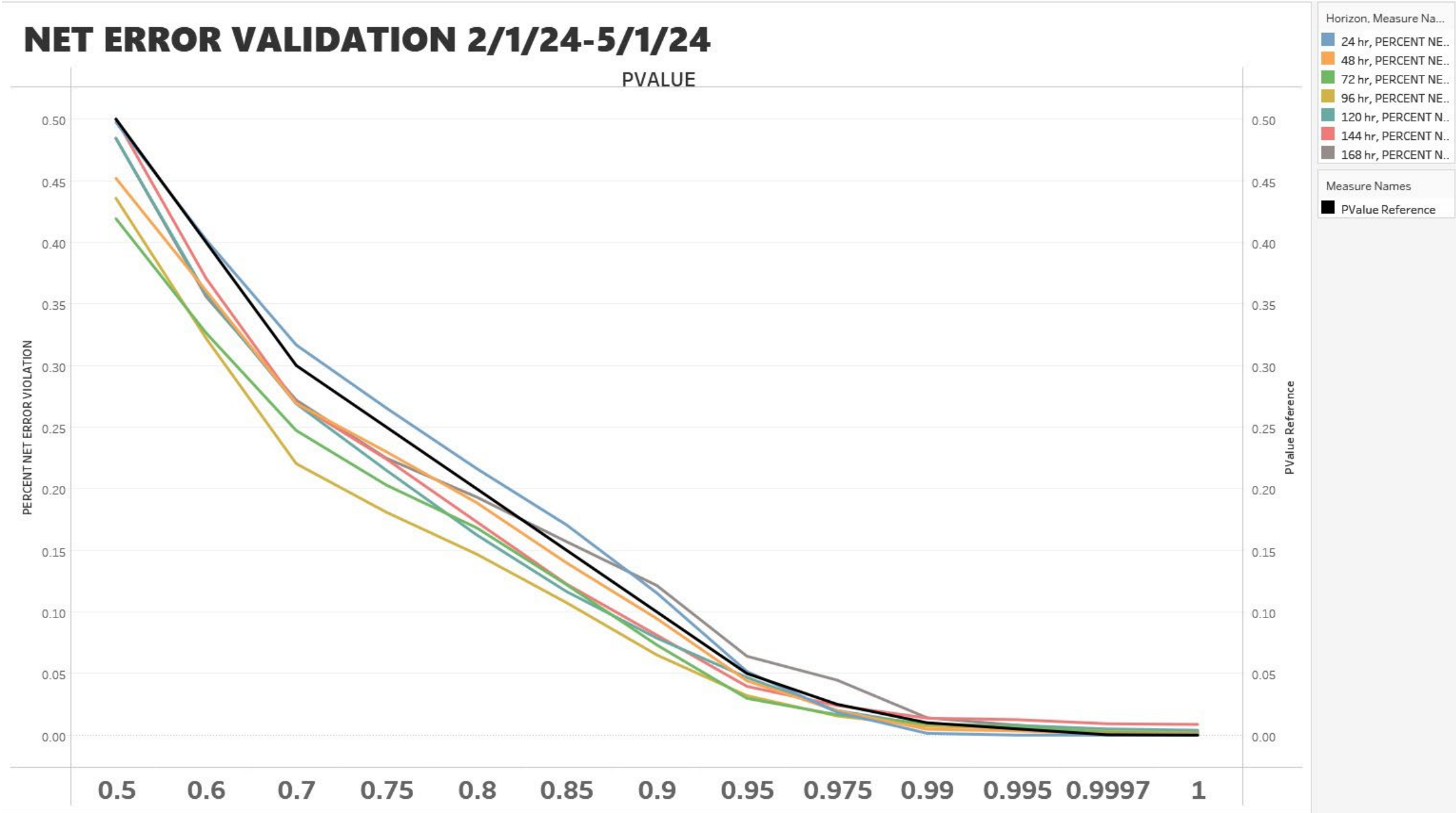
LOAD ERROR VALIDATION 2/1/24 - 5/1/24



WIND ERROR VALIDATION 2/1/24-5/1/24



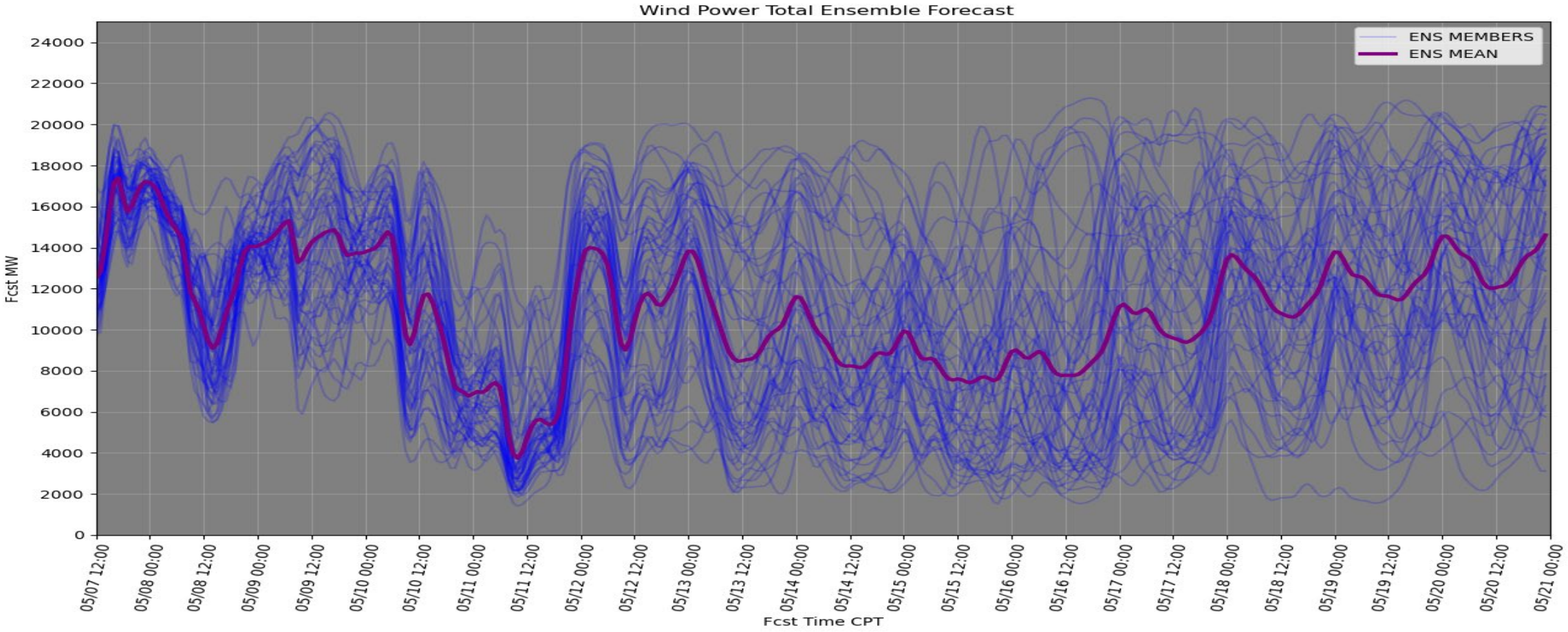
NET ERROR VALIDATION 2/1/24-5/1/24



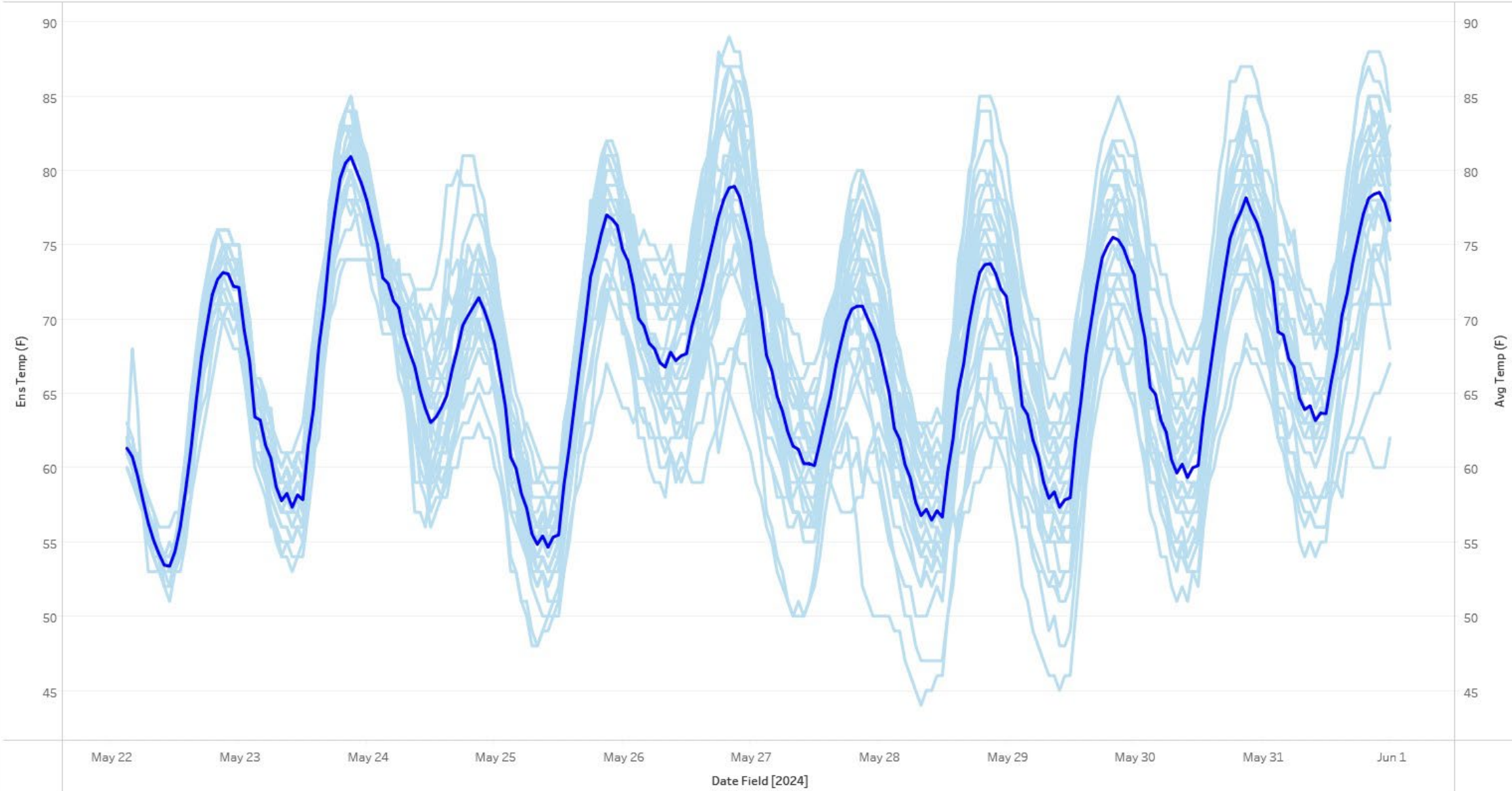
ENSEMBLE

ERROR FORECASTING

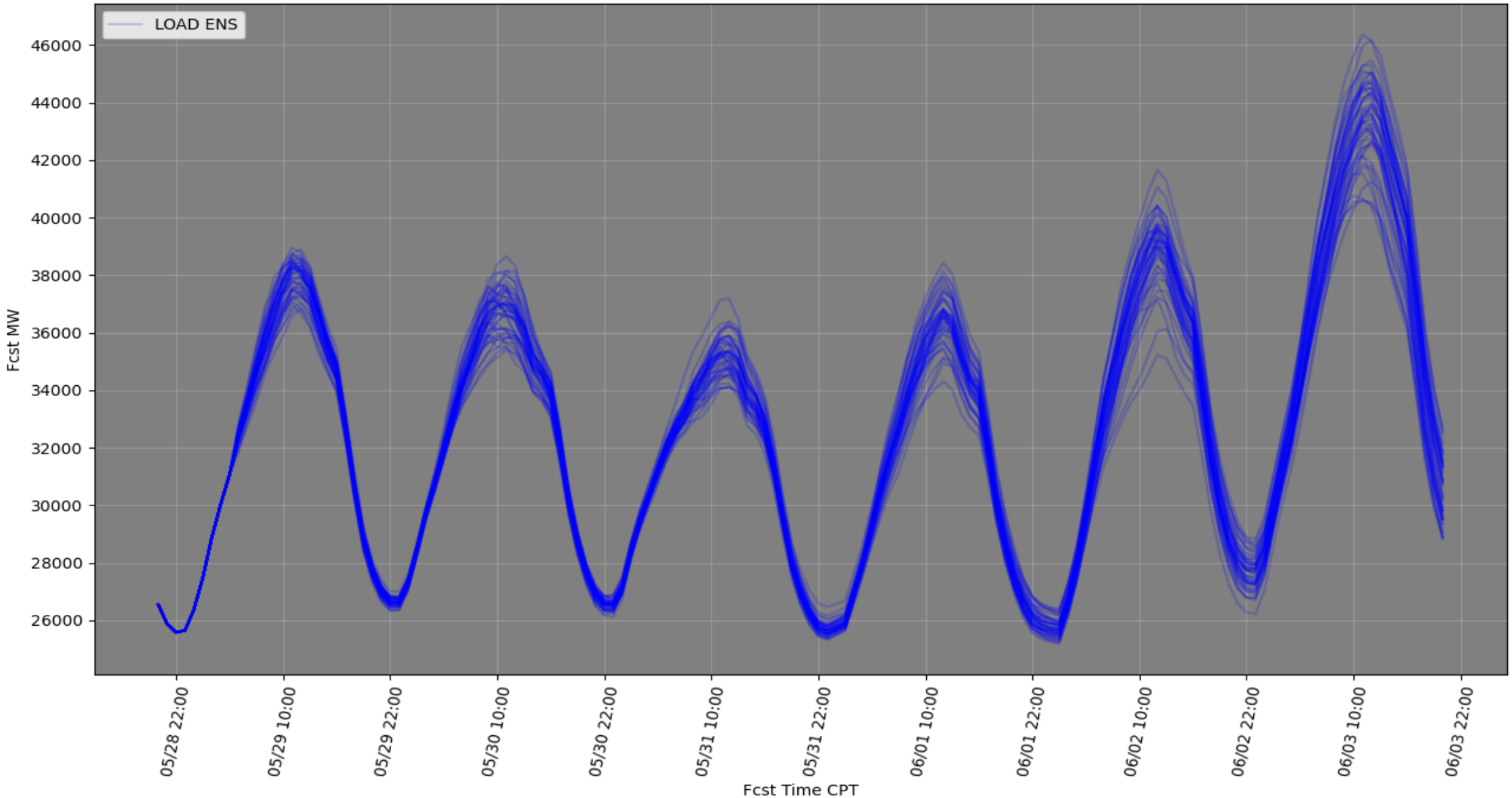
WIND POWER FORECAST ECMWF ENSEMBLE



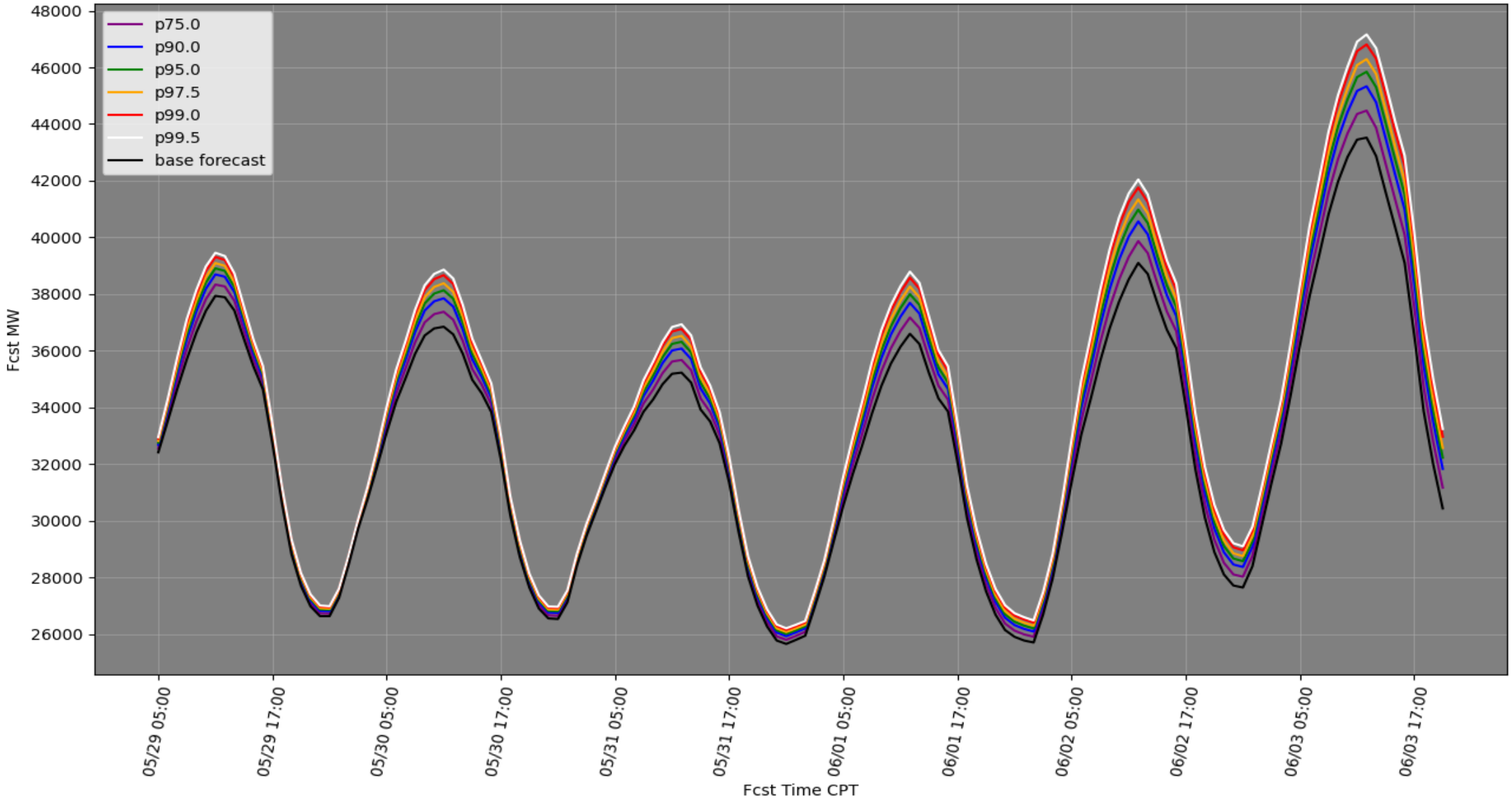
Kansas City GEFS Temperature Forecast



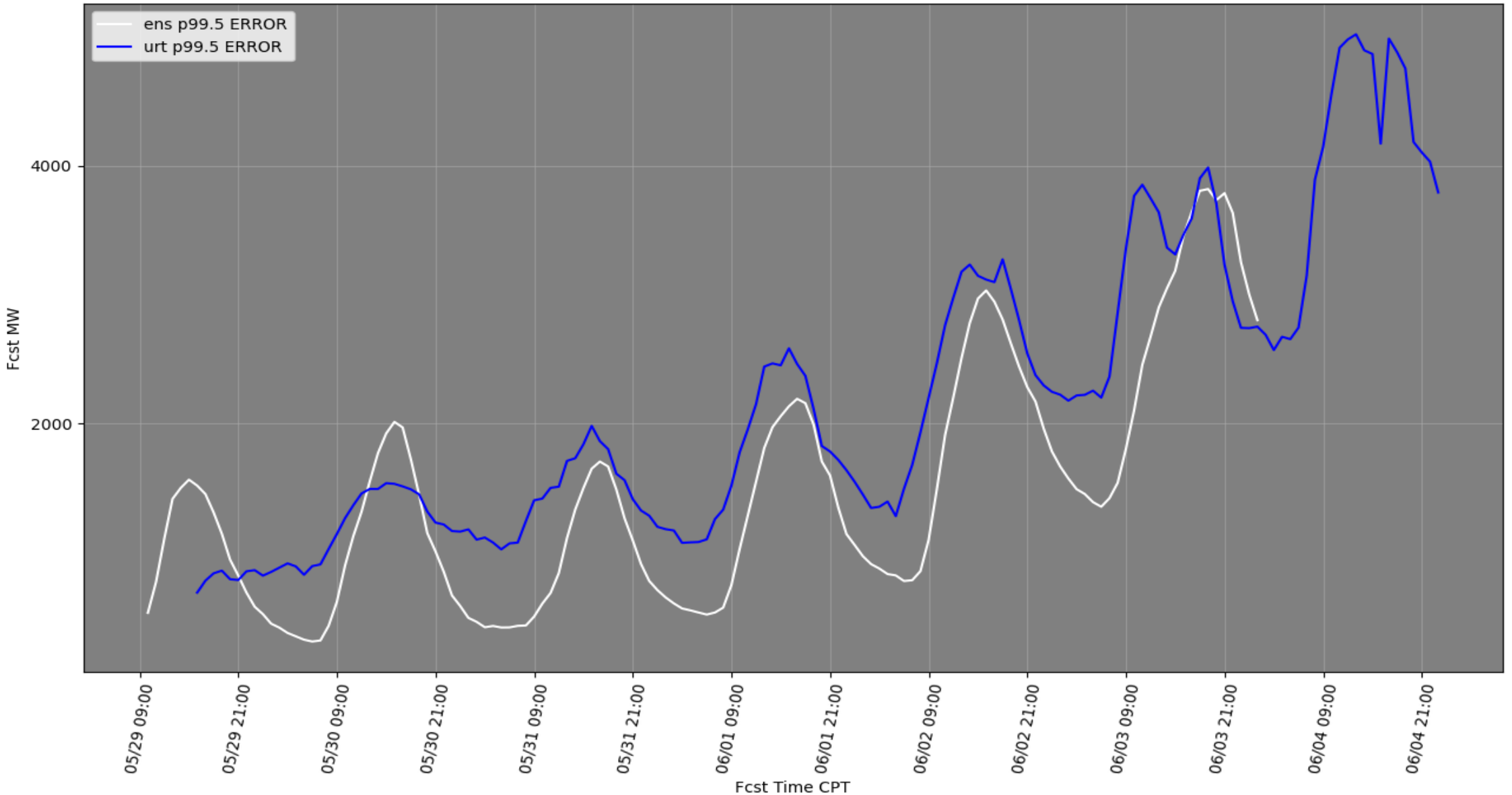
Ensemble Load Forecast



Probabilistic Load Forecast



Historical vs Ensemble Load Error Forecast



ENSEMBLE ERROR ADVANTAGES

- Can be used with historical error to identify time horizons of above or below average confidence
- Captures uncertainty based on spread of underlying inputs (i.e. Temperature, wind, cloud cover…)
- No historical data required for confidence intervals

JEFF BASKIN

Uncertainty Response Team - Operations

Southwest Power Pool

Please feel free to contact me at jbaskin@spp.org