



Operations of Future and Data-driven Uncertainty Management: Net Uncertainty Forecast and Dynamic Reserve in MISO

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Panel: ML/AI for electricity market and grid operations under extreme weather

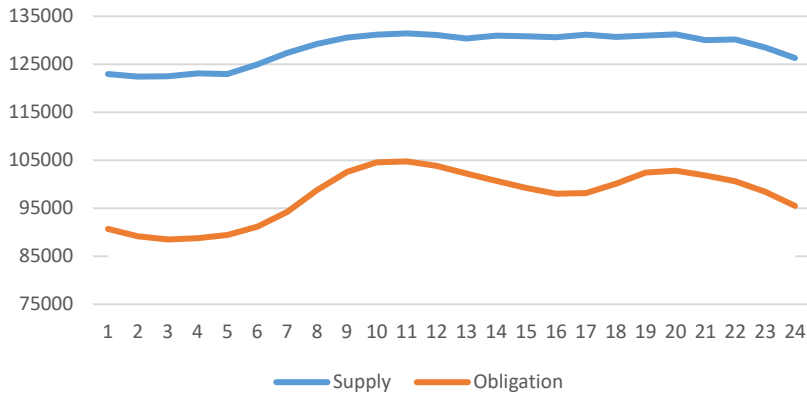
Key takeaways



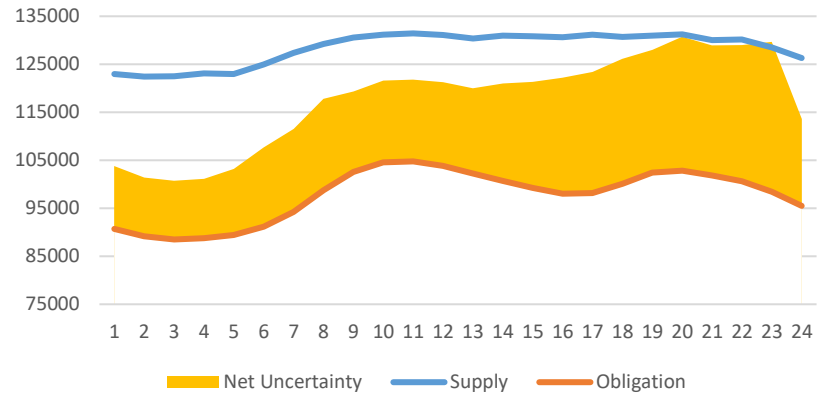
- MISO develops Net Uncertainty forecast model to make quantitative prediction of net uncertainty (MW) and derives qualitative uncertainty labels (L/M/H) for the Next-Day time horizon on daily basis.
- MISO sets Commitment Threshold and Short-Term Reserve Requirement dynamically based on L/M/H uncertainty.
- This endeavor is a progress toward quantified, data-driven decisions to enhance uncertainty management.

Experience in Winter Storm Elliot accelerates MISO's endeavor toward quantified, data-driven methods to enhance uncertainty management.

Before storm, MISO anticipated sufficient margin between supply and demand.

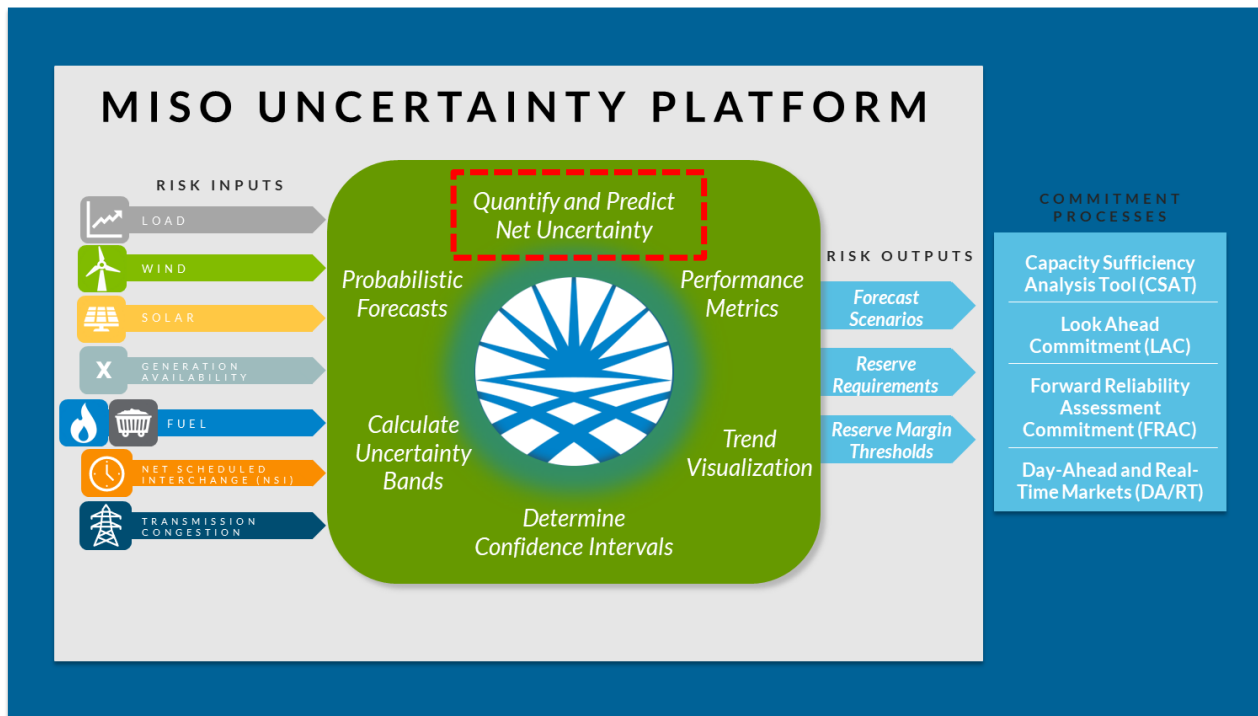


During storm, margin diminished rapidly because of high load and significant forced outage.



What can we do better?

MISO launches Uncertainty Platform, a multi-year initiative to improve Uncertainty Management.



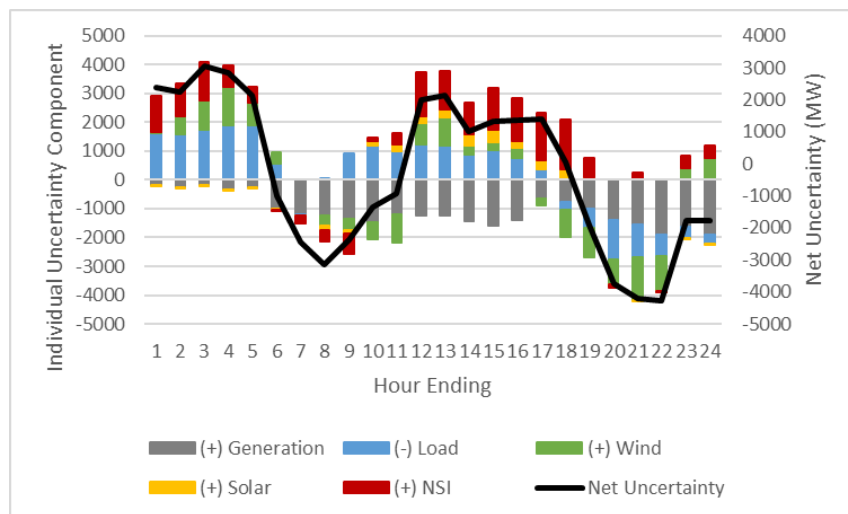
Application of **Net Uncertainty Forecast**:

To set the following dynamically on daily basis:

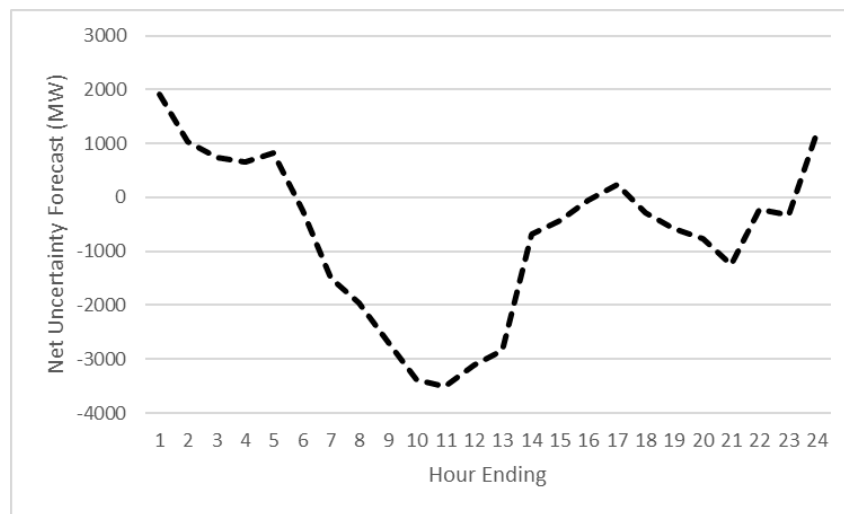
- Next-Day FRAC **Commitment Threshold Recommendation**
- Short-Term Reserve (STR) **Requirement**

Net Uncertainty Quantification and Forecast Task

A sample day of materialized Net Uncertainty



Our task: forecast Net Uncertainty of Next-Day



For the Commitment Threshold and Dynamic Reserve application, MISO defines and quantifies the Net Uncertainty as the difference between **Next-Day FRAC** and **Real-Time**.

But how do we do it?

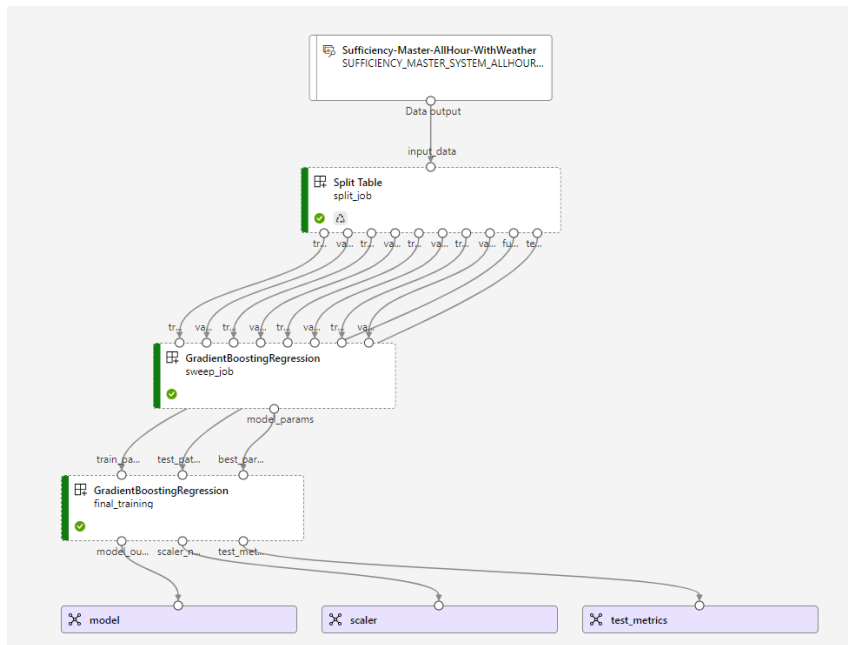
Net Uncertainty Forecast Model

- Leveraging the forecasts information we already have and build a model for Net Uncertainty forecast
 - Establish the relationship between **materialized Net Uncertainty** and corresponding historical **forecasts** of key components, including Load, Wind, Solar, and Weather



Hourly TimeStamp	Load Frct	WIND Frct	SOLAR Frct	Weather Frct					Materialized Net Uncertainty
				CloudCover	DewPoint	DryBulb	RainFall	WindSpeed	
	69637	6780	392	34.37	40.39	64.07	0.00	11.46	-183
	71145	7737	1	32.62	40.59	61.31	0.00	9.36	-1134
	70380	8853	0	32.17	40.60	58.97	0.00	8.86	-1751
[Redacted]	68148	9397	0	31.89	40.89	57.04	0.00	8.68	-402
	65466	9664	0	32.17	40.99	55.30	0.00	8.50	1223
	62573	9769	0	38.48	41.09	54.40	0.00	8.37	2714
	60372	10142	0	36.66	40.79	53.60	0.00	7.49	2399

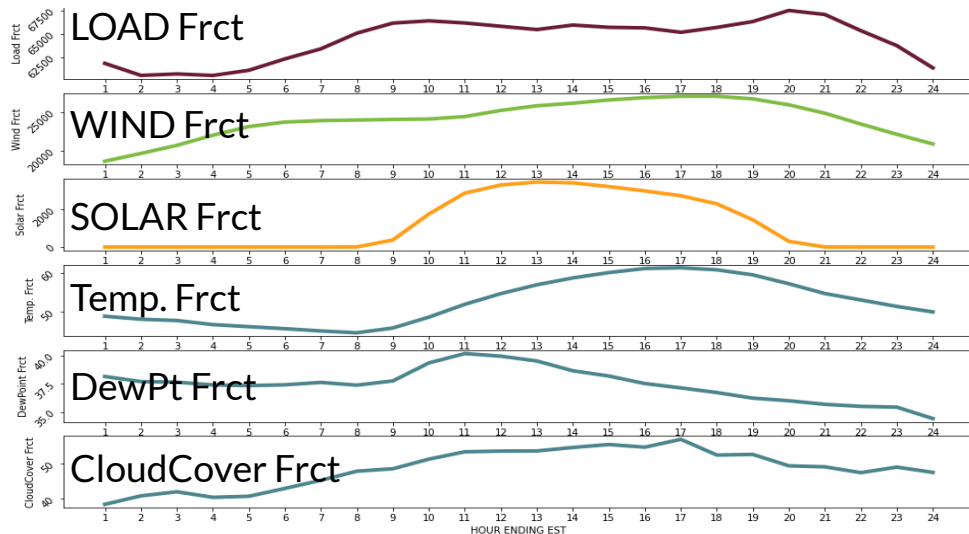
Utilizing latest machine-learning capability to develop and maintain the Net Uncertainty forecast models.



A screenshot of model training in Microsoft Azure ML Platform

- Training dataset: hourly time series data since January 2017
 - Updated daily
- Net Uncertainty forecast model in PROD
 - Gradient Boost based model
- Model retraining triggers:
 - Time based: weekly model re-train
 - Cost-based: model re-train if materialized uncertainty exceeds pre-determined threshold
 - Metrics for deciding if re-trained model is better

Net Uncertainty Forecast and Application Example



and other weather Frct

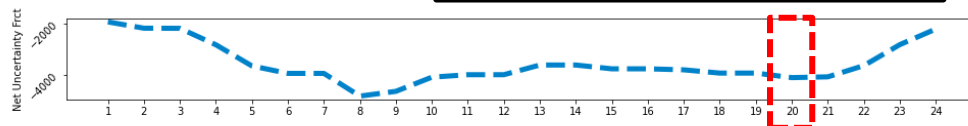
Input data (hourly)



Net Uncertainty Forecast Model
- additional featurization



Output Net Uncertainty Frct
(hourly)



Derive Uncertainty Label (L/M/H) based on frct MW at peak load hour



Set Next-Day Commitment Threshold Recommendation and STR Requirement based on Uncertainty Prediction (L/M/H)

[MKTDAY Redacted]

Next-Day FRAC Commitment Threshold Recommendation

Region	Frct PeakHE	Forecast Uncertainty	Commitment Threshold (Percentage)		Commitment Threshold (MW)
Systemwide	17	1-Low (Green)			
North/Central	17	1-Low (Green)	[Redacted]	[Redacted]	[Redacted]
South	17	1-Low (Green)			

Short Term Reserve Requirement Recommendation

Systemwide Requirement

(Override is added on top of Requirement)

Hour	STR Requirement (MW)	Override
1	4,200	0
2	4,200	0
3	4,200	0
4	3,500	0
5	3,500	0
6	4,200	0
7	5,400	0
8	5,400	0
9	5,400	0
10	5,400	0
11	5,400	0
12	5,400	0
13	4,200	0
14	3,500	0
15	3,500	0
16	3,500	0
17	3,500	0
18	3,500	0
19	3,500	0
20	3,500	0
21	3,500	0
22	4,200	0
23	4,200	0
24	4,200	0

North/Central Requirement

(Override is added on top of Requirement)

Hour	STR Requirement (MW)	NonZone MSSC STR RPE Override
1	3,400	0
2	3,400	0
3	2,500	0
4	2,500	0
5	2,500	0
6	3,400	0
7	4,000	0
8	4,000	0
9	4,000	0
10	4,000	0
11	4,000	0
12	4,000	0
13	3,400	0
14	2,500	0
15	2,500	0
16	2,500	0
17	2,500	0
18	2,500	0
19	2,500	0
20	2,500	0
21	2,500	0
22	3,400	0
23	3,400	0
24	3,400	0

South Requirement

(Default=Default largest generator online from each zone)

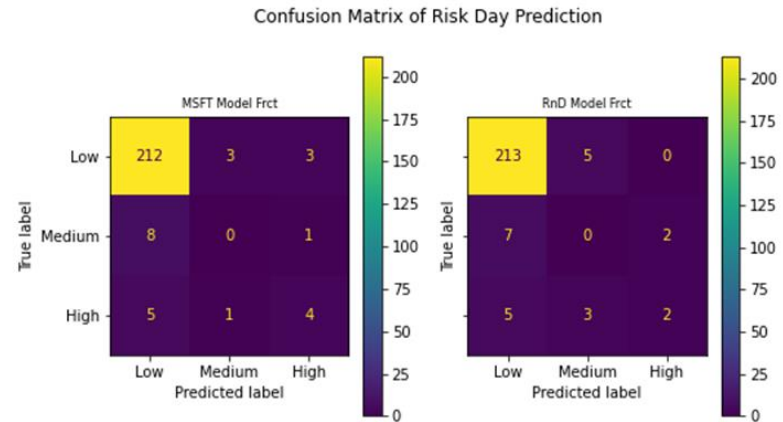
Hour	STR REQ	Zone 8 MSSC STR RPE Override
1	Default	Default
2	Default	Default
3	Default	Default
4	Default	Default
5	Default	Default
6	Default	Default
7	Default	Default
8	Default	Default
9	Default	Default
10	Default	Default
11	Default	Default
12	Default	Default
13	Default	Default
14	Default	Default
15	Default	Default
16	Default	Default
17	Default	Default
18	Default	Default
19	Default	Default
20	Default	Default
21	Default	Default
22	Default	Default
23	Default	Default
24	Default	Default

MISO is actively tracking the performance of net uncertainty forecasts against actuals for opportunities of model improvement

- The net uncertainty forecast process was put into production in January 2024 and immediately helped uncertainty management during winter storm Heather Jan 14-17, 2024.

“MISO increased its STR requirements to reflect the added uncertainty, which improved the markets’ commitments and pricing.”

- Potomac Economics Winter 2024 Quarterly Report





Thank you

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