



Load, Weather, and Renewables in Probabilistic Modeling

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Purpose & Key Takeaway

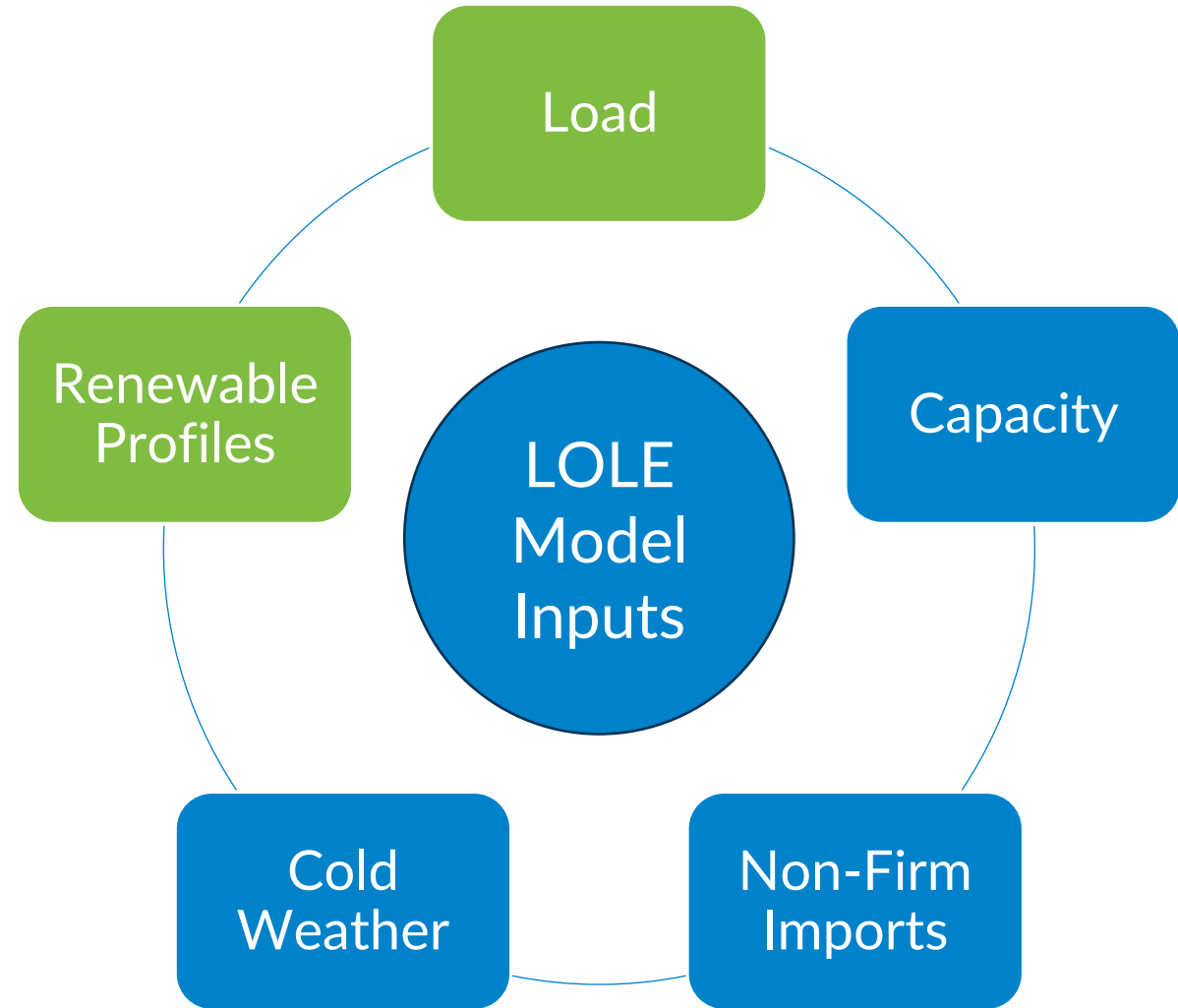
Purpose

Review the MISO Load Development process and recent enhancements to the Wind Profile Development process.

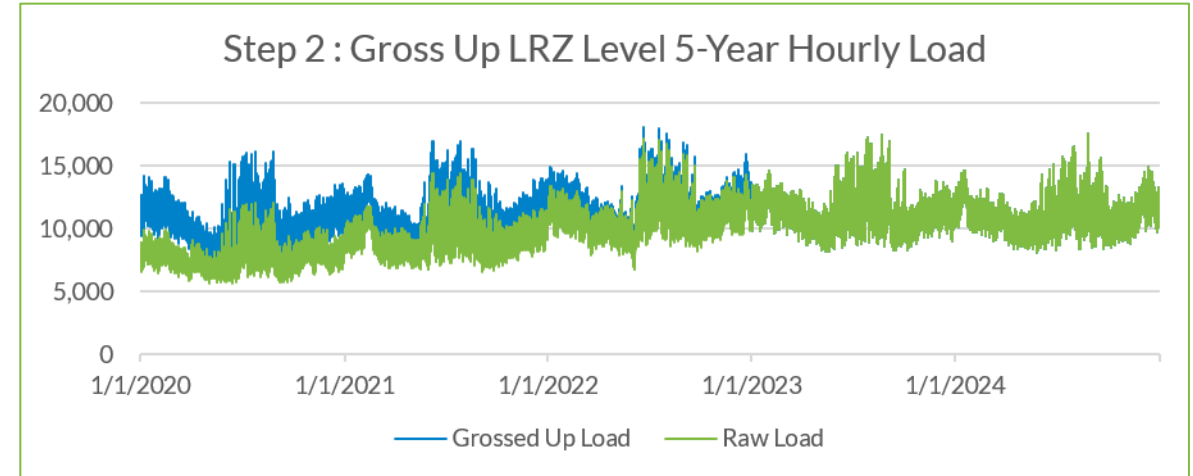
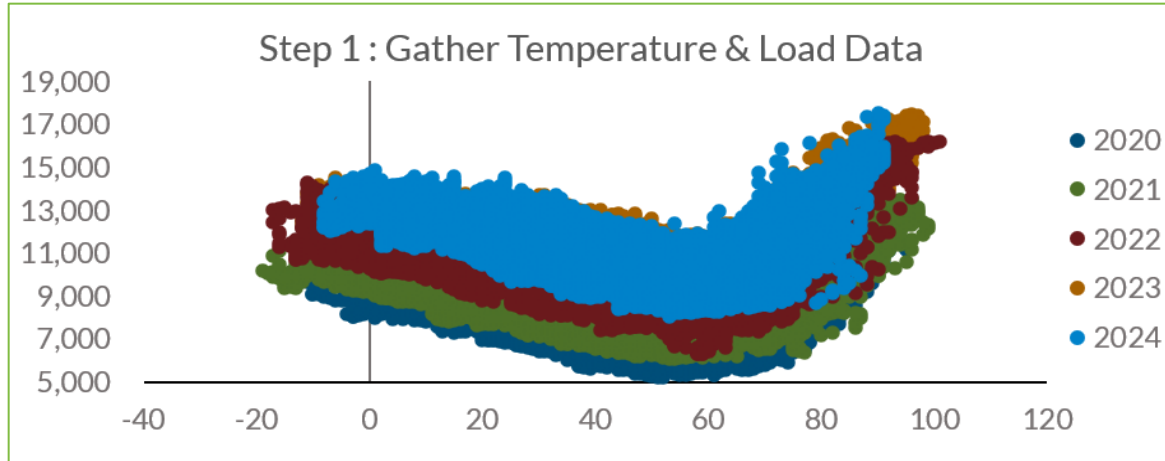
Key Takeaways

- MISO utilizes historical load data and weather data to create 30-year hourly load profiles in the LOLE model.
- MISO has made updates to its Wind Profile development process to better reflect wind generation and is continuing to work on further enhancements to the process.

Major Components of the LOLE Probabilistic Study

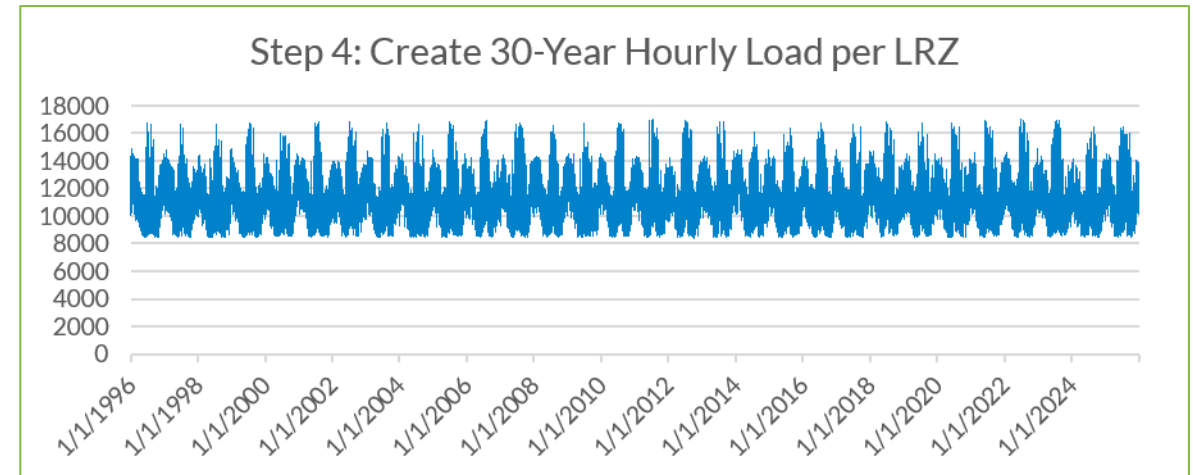


Load Development



Step 3 : Regression Analysis

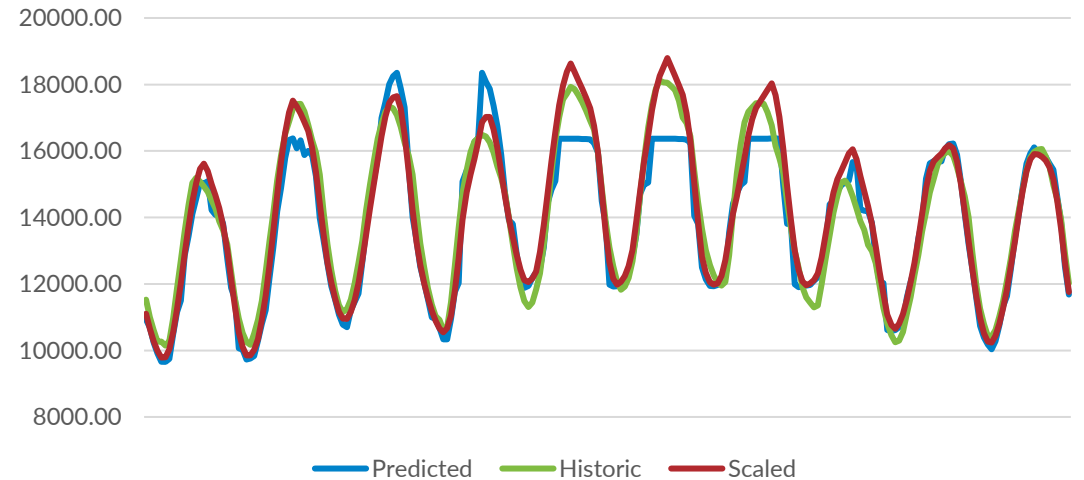
- Training and fitting of the model to the most recent 5 years of load and temperature



Load Development

Step 5: Extreme Analysis

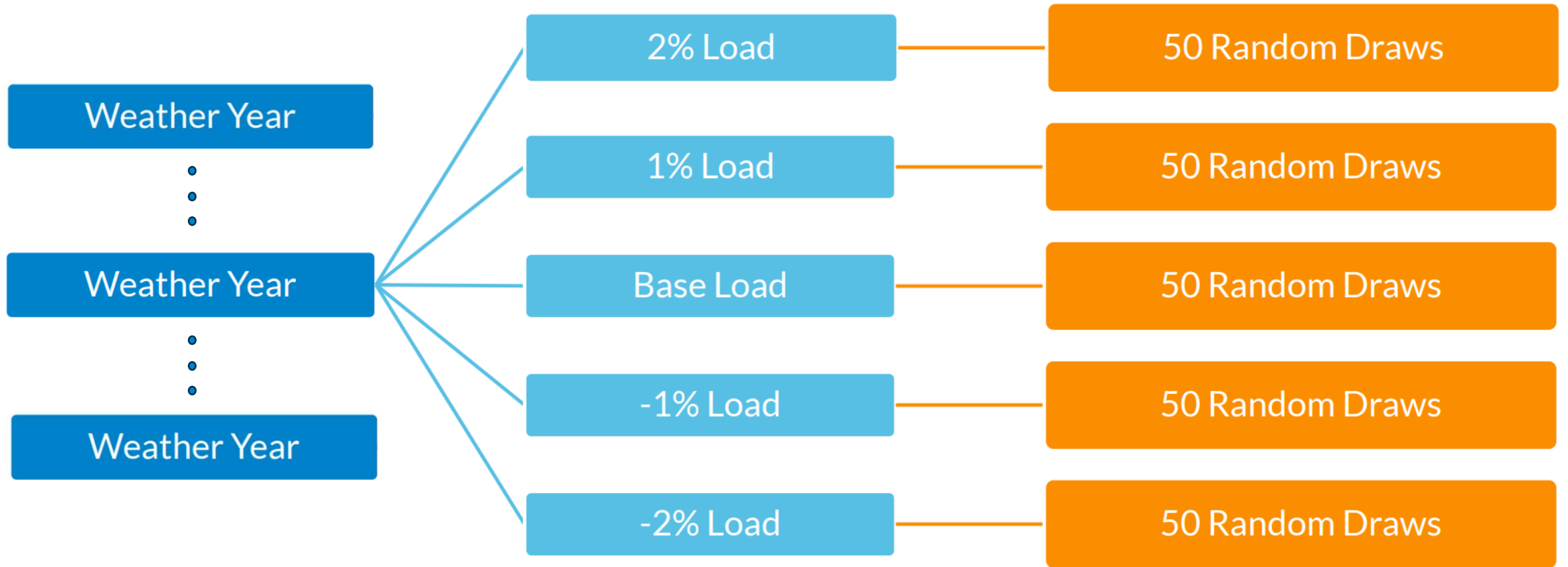
- 5-year regression doesn't include all temperatures seen historically and tends to underestimate load in those temperatures
- Fit a linear regression on the extremes to be used as a reference for scaling.



Step 6: ZCPF Scaling to Forecasts

- Predicted load shapes are scaled so that the monthly and zonal peak averages of the 30-year load shapes match each Local Resource Zone's monthly Zonal Coincident Peak Load Forecast
- Ratio of prompt year Non-Coincident Peak Forecast to Zonal Coincident Peak Forecast is applied to future year Non-Coincident Peak Forecasts to develop outyear load forecast scalars

LOLE Iteration Framework



Each weather year is associated with 5 load scenarios, to account for load uncertainty.

50 Monte Carlo simulations are performed for each load scenario.

The model currently uses 30 weather years, resulting in 150 load forecast scenarios and 7,500 random draws using a Monte Carlo method*

Wind Profile Development

Wind Profiles – Gather Data

- Meteorological Data

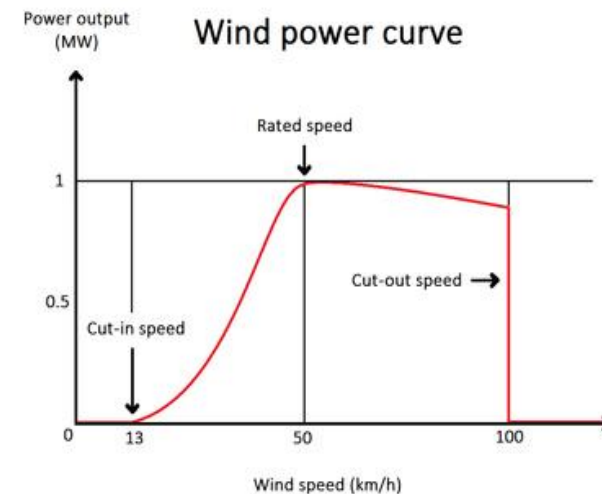
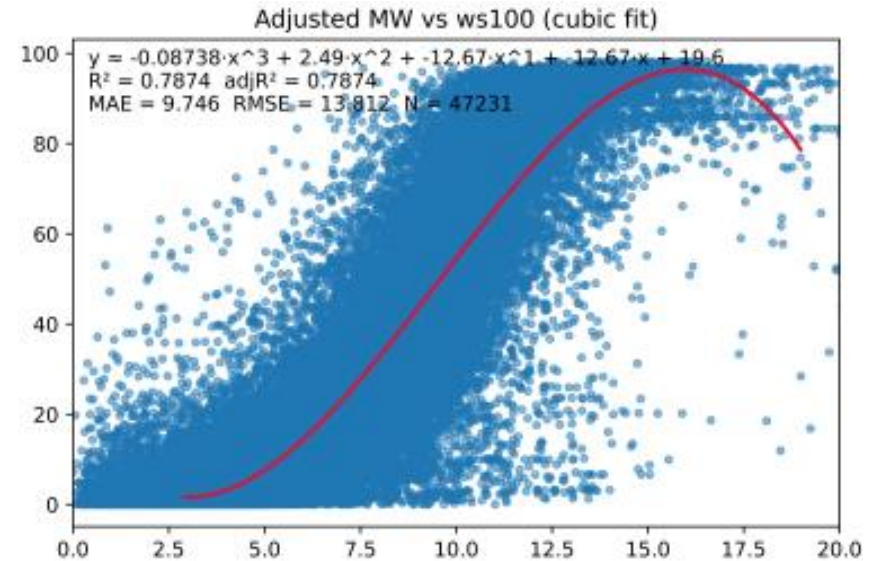
- European Centre for Medium-Range Weather Forecasts (ECMWF) ERA5 wind speed (100m), with optional other inputs such as temperature (2m), surface pressure, etc
- Data collection since 1995, hourly data covering MISO wind fleet footprint based on proximity of each wind farm and location; 31km x 31km resolution

- Operational Data

- Historical MISO wind metered generation at resource and zonal level (post 2012):
 - Resource attributes: nameplate capacity, location coordinates, commissioning date, and model changes if available
 - Availability records: manual redispatch, curtailment, and maintenance

Wind Profiles – Develop Power Curves

- Individual farm level training/regression to capture local effects, includes adjustments:
 - Hub Height
 - Cut in/cut off speed
- Aggregated results at zonal level to create 10 individual zonal profiles for the MISO Local Resource Zones (LRZ)

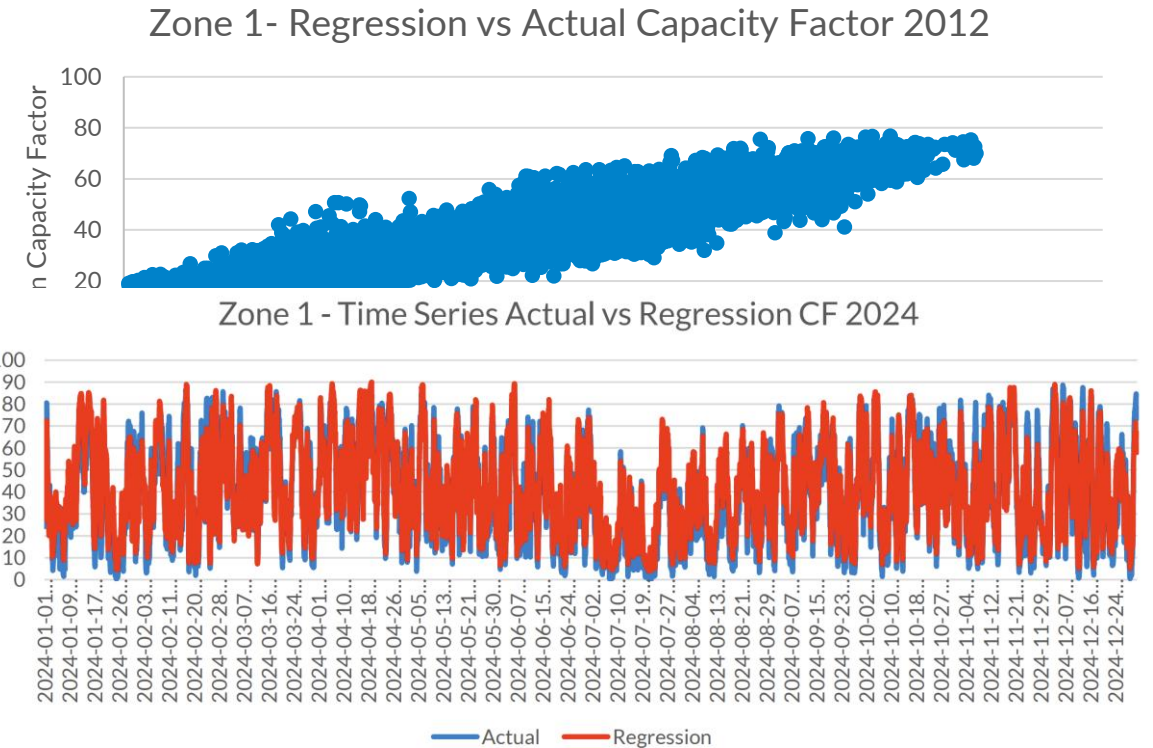


Wind Profiles - Validation

- The regression-based wind profiles were tested against actual 2024 operational data to confirm model robustness under current fleet conditions.
- Results show strong correlations ($R^2 \approx 0.9$) and low RMSE values for most of the zones, demonstrating stable predictive performance beyond the original training period.

Zonal Fit Results*

LRZ	R2	RMSE (%)
1	0.90	7.45
2	0.90	7.64
3	0.90	8.54
4	0.89	9.50
6	0.80	12.95
7	0.89	8.53

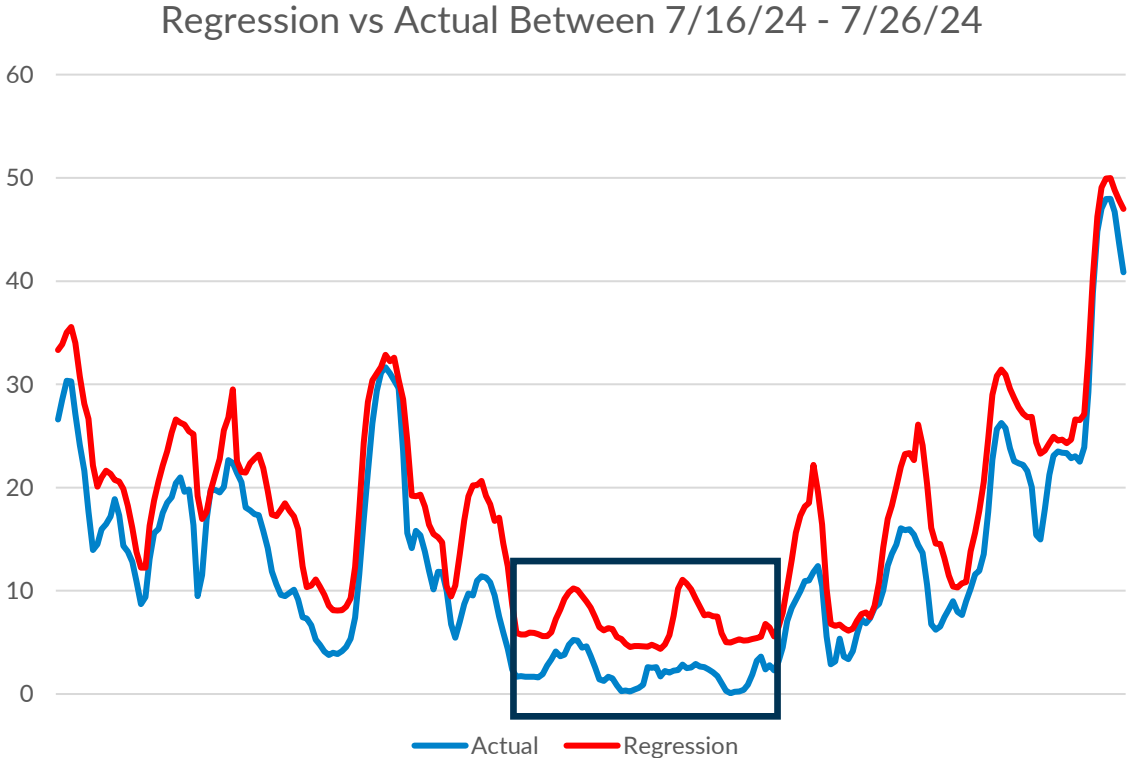
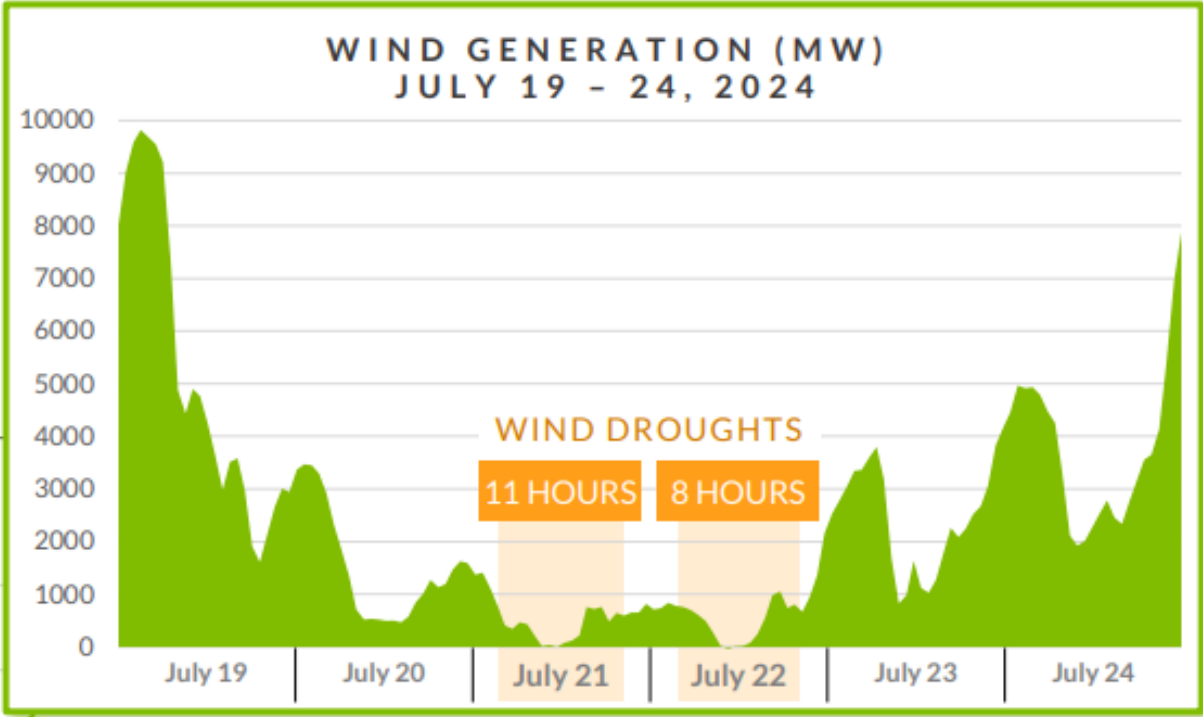


*Only Zones with >3 Units were included

*RMSE: Root Mean Square Error

Wind Profiles - Validation

Identification and validation of wind droughts

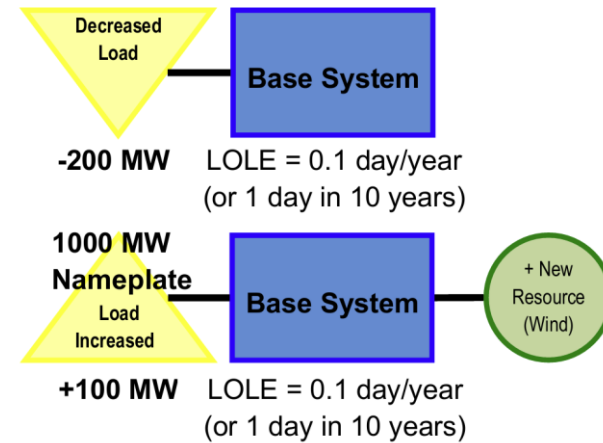


Wind Accreditation

- Transition to new accreditation methodology in PY28-29

Average Effective Load Carrying Capability (ELCC) - Current Process for PY27-28

- Determines value of the resource class by evaluating the system with and without the resource at the same LOLE seasonal value.



Direct Loss of Load (DLOL) - Future Process for PY28-29+

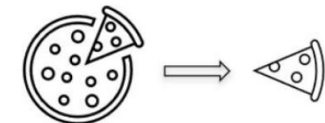
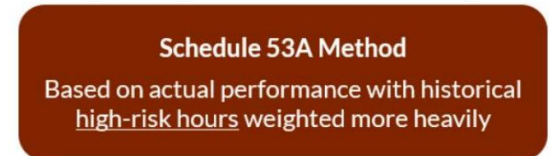
- Determines the value of a resource class/resource during the weighted risk hours in the model using a 2-step process:
 1. Determine resource class-level accreditation, based on the probabilistic model ("Critical Hours")
 2. Allocation of class accreditation to resources, based on historical high-risk hours ("Tier 1 & Tier 2 RA Hours")

Class-Level (Prospective/Probabilistic)



Step 1: Determining Class-level accreditation

Resource-Level (Retrospective/Deterministic)



Step 2: Allocating Class-level accreditation to each Resource in the Resource Class

Challenges and Next Steps

- **Continue enhancing extreme-event modeling**
 - Improve representation of high-impact weather conditions, e.g heat waves, cold-weather events, wind drought, icing risk/polar vortex etc.
 - Incorporate extreme-event logic into LOLE, ELCC, DLOL, and long-term planning studies to better reflect reliability risk under stressed system conditions.
- **Improve meteorological data collection and correlated weather-event analysis**
 - Strengthen analysis of correlated weather patterns across load, renewable resources, outages, and transmission conditions.
 - Develop consistent and standard weather-year datasets and QA/QC processes to support Resource Adequacy, Planning, Forecasting, and R&D studies.

Contact

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