ACPET Policy Bulletin

Bridging the Climate-Energy Data Gap: A State-Level Electricity Demand Dataset for India's Energy Transition

KEY POLICY RESEARCH QUESTIONS

1. **How do climate variables influence electricity demand across Indian states, especially during extreme heat or weather events?**
2. **Can high-resolution climate-informed electricity demand data improve modeling of India's future power system and renewable integration?**
3. **How can such data empower state-level policy decisions on energy resilience and demand-side interventions?**

METHODOLOGY USED BY ENERGY FUTURES LAB

Data Sources:

1. Hourly ERA5 reanalysis data for key climate variables (temperature, wind speed, humidity, radiation) for all Indian states.
2. Daily state-wise electricity demand data from POSOCO (April 2013–present).

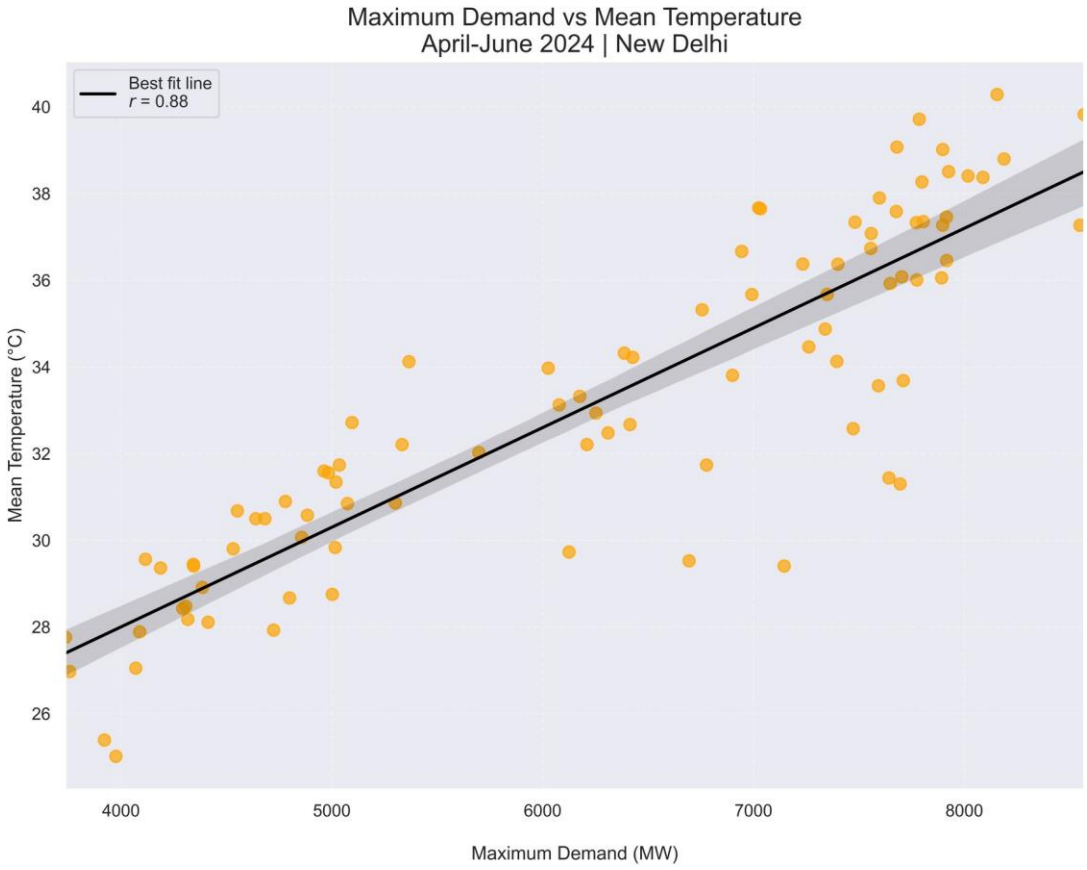
Data Processing:

1. Climate variables aggregated to daily resolution using statistically relevant metrics (max, mean, diurnal range).
2. Created a harmonized, merged dataset linking climate variability with electricity demand across states.

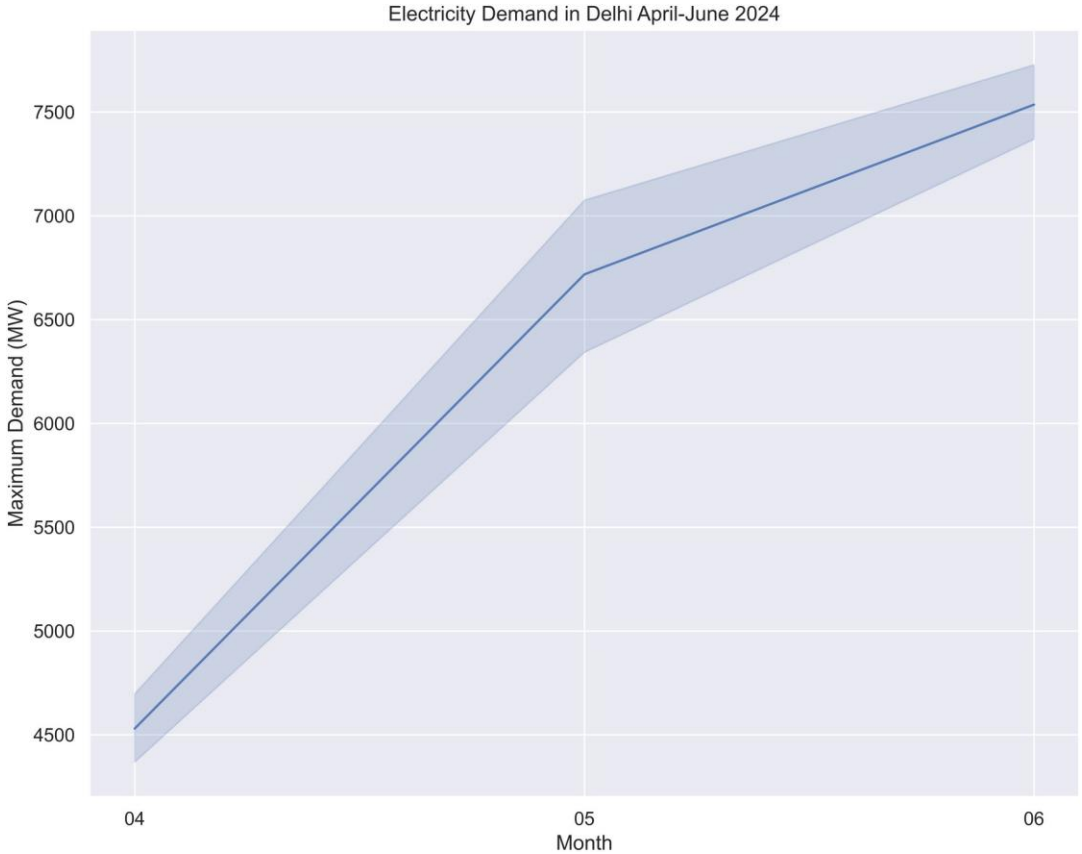
Modeling Approach:

1. Time-series exploratory analysis to find optimal predictors of electricity demand.
2. Machine learning (Decision Trees, XGBoost, and LSTM models) for forecasting.
3. Correlation and scenario-based analysis for future climate-warming effects on cooling demand and system load.

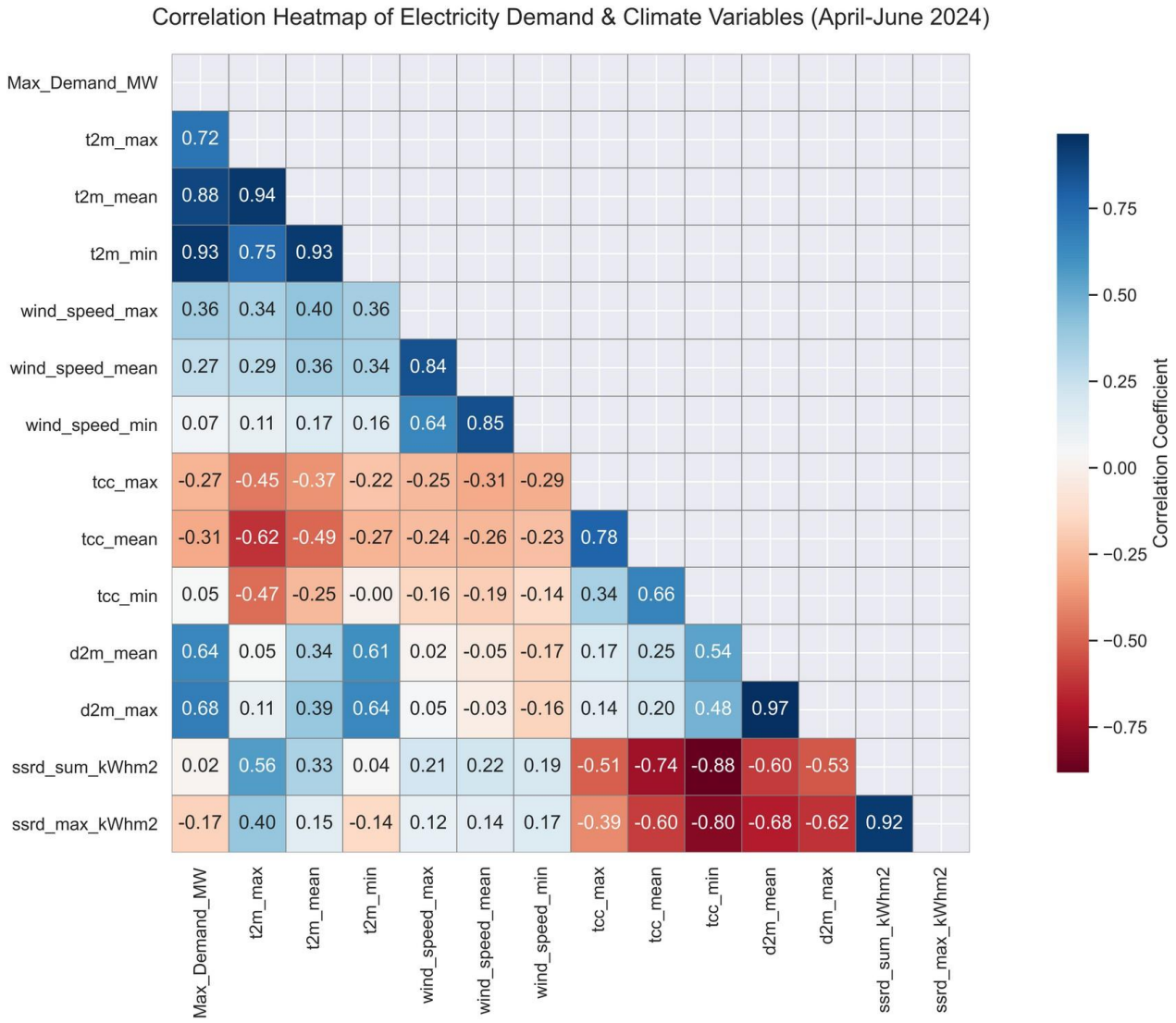
DELHI NCR – TEMPERATURE VS PEAK DEMAND (APRIL 2024)



DELHI NCR PEAK ELECTRICITY DEMAND TIME SERIES | APRIL-JUNE 2024



HEATMAP – CORRELATION BETWEEN CLIMATE AND DEMAND INDICATORS (APRIL-JUNE 2024)



KEY RECOMMENDATIONS

1. Build dynamic state-level energy models incorporating real-time and climate-informed demand to prepare for heatwave- or monsoon-induced peak load stress.
2. Institutionalize climate-demand linked datasets at the national level for better scenario modeling (e.g., for Load Dispatch Centers, state energy departments).
3. Invest in research on temperature-humidity driven cooling demand forecasting for both residential and commercial sectors.
4. Use this data to prioritize climate-resilient grid investments in vulnerable states like Delhi, Uttarakhand, Rajasthan, and Odisha.

COMING UP...

1. Understanding the behaviour of Delhi NCR's electricity demand for the year 2024-2025 and how the climate indicators influence the demand?
2. Perform Machine Learning methods such as XGBoost, LSTM and Decision trees to see which of them predicts electricity demand using climate predictors?
3. Correlation of climate variables with electricity demand data for Rajasthan, Uttarakhand and Kerala

Upcoming Project

This brief sets the stage for Project 2: "Mapping India's Renewable Potential: Solar and Wind Capacity Under Future Climate Scenarios"