Predictive Trend Analysis of Household Energy Consumption

# 1. Problem Statement

Households and utilities often lack predictive foresight, making demand spikes, billing shocks, and grid strain harder to manage. This POC tests whether an LSTM sequence model can reliably predict short-term consumption trends using past loads and exogenous variables (e.g., temperature), and whether such forecasts can inform actionable insights.

# 2. Objectives

The objectives of this POC are:

1. 1. Implement an LSTM model to forecast hourly household energy consumption.
2. 2. Build a lean feature set including lags, rolling stats, weather covariates, and calendar features.
3. 3. Evaluate model accuracy using backtesting and standard metrics.
4. 4. Provide a compact dashboard to visualize forecasts and insights.
5. 5. Document feasibility and recommendations for scaling.

# 3. Scope

## In-Scope

- Data preparation and ingestion.

- LSTM model development and evaluation.

- Baseline comparator model.

- Dashboard for visualization.

## Out-of-Scope

- Full MLOps pipeline.

- Real-time streaming or API integration.

- Behavioral recommendation engine.

- Multi-region rollout.

# 4. Methodology

The methodology includes data preparation, LSTM model development, evaluation, and dashboard creation.

## LSTM Modeling Details

- Input window: 7–14 days of historical data.

- Output window: 24 hours (primary horizon).

- Features: lagged consumption, weather variables, calendar flags.

- Model: 1–2 LSTM layers with dropout and dense output head.

- Evaluation: Rolling-origin backtesting with MAPE, MAE, RMSE.

# 5. Architecture Diagram

Diagram Placeholder: Predictive System Architecture

[Insert architecture diagram image here]

# 6. Deliverables

- Cleaned dataset and feature set.

- LSTM model and baseline comparator.

- Evaluation metrics and backtesting results.

- Dashboard for forecast visualization.

- Final POC report with findings and recommendations.

# 7. Success Criteria

- Day-ahead forecast MAPE ≤ 15%.

- Consistent performance across rolling backtests.

- Clear visualization of forecasts and drivers.

- Document feasibility for scaling.