# **Energy Consumption Forecasting Report**

**Project Title:** Predicting Future Energy Consumption Using Time Series Models  
 **Duration Covered:** January 1, 2022 → March 30, 2024  
 **Forecast Horizon:** 90 Days (January 1, 2024 → March 30, 2024)

## **1. Objective**

To forecast daily energy consumption and provide actionable recommendations for demand planning, resource allocation, and maintenance scheduling.

## **2. Data Overview**

* **Original Data Fields:** Timestamp, Consumption, Region, Customer Type, Temperature, Humidity, Population, Industrial Density
* **Time Range:** January 1, 2022 → December 31, 2023
* **Frequency:** Half-hourly readings (resampled to daily mean for modeling)

## **3. Data Cleaning & Preparation**

### **Missing Values**

* **Temperature & Humidity:** Imputed using time-based interpolation within each region
* **Consumption:** Imputed using a predictive regression model for higher accuracy

### **Outlier Handling**

* Used IQR method to detect and smooth anomalies in Temperature, Humidity, and Consumption without dropping rows

### **Feature Engineering**

* Extracted hour, weekday, and month from Timestamp
* Encoded CustomerType and IndustrialDensity

## **4. Models Used**

### **A. Prophet**

* **Approach:** Trend + seasonality decomposition
* **Forecast Horizon:** 90 days
* **MAPE:** 3.52%
* **RMSE:** 2.22 kWh

### **B. ARIMA**

* **Stationarity Tests:**
  + ADF: p = 0.0 (stationary)
  + KPSS: p = 0.1 (weak evidence against stationarity)
  + PP: p = 0.0 (stationary)
* **Best Order Chosen:** (75, 0, 75)
* **MAPE:** 3.58%
* **RMSE:** 2.41 kWh

## **5. Forecast Summary**

* **Peak Demand Month:** January
* **Lowest Demand Days:** Feb 04, Feb 11, Feb 12, Feb 13, Feb 18
* **Weekday Usage > Weekend Usage:** Yes

## **6. Recommendations**

* ✉️ **Increase Capacity** in January to handle forecasted peak demand.
* ✉️ **Schedule Maintenance** during low demand days in early February.
* ✉️ **Add Surge Buffers** for weekdays due to higher weekday demand compared to weekends.

## **7. Visualizations**

* Forecast vs Actual Trends
* 90-day Forecast Curve (Prophet & ARIMA)
* Decomposition of Trends & Seasonality
* Outlier and Imputation Handling

## **8. Conclusion**

Both Prophet and ARIMA successfully modeled the trend with high accuracy. Prophet performed slightly better. The forecast enables informed operational decisions for the next quarter.