**Energy Demand Optimization Using Load Forecasting**

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**Tools Used:** Python (pandas, matplotlib, statsmodels, sklearn)  
**Dataset:** AEP Hourly Energy Consumption (2004–2018) from PJM Interconnection (via Kaggle)

**1. Introduction**

In the context of global energy efficiency and smart grid management, accurate forecasting of electricity demand is crucial. This project aims to develop a time-based load forecasting model that assists in production planning and capacity optimization.

**2. Objective**

To analyze historical hourly energy consumption data and apply time series forecasting (ARIMA) to predict demand. The goal is to support production and maintenance scheduling based on expected demand trends and perform a scenario analysis for demand spikes.

**3. Data Description**

* **Source:** Kaggle (AEP\_hourly.csv)
* **Time Range:** 2004–2018
* **Frequency:** Hourly
* **Variables:**
  + Datetime: Timestamp of energy consumption
  + AEP\_MW: Actual power consumption in megawatts (MW)

**4. Methods**

**4.1 Data Preprocessing**

* ZIP file was read directly using Python.
* Converted timestamp to datetime format and set as index.
* Resampled data to daily average to reduce noise.

**4.2 Forecasting Model**

* Used ARIMA(5,1,0) model with statsmodels.
* Predicted daily demand for the most recent year.
* Visualized predictions versus actual values.

metin, öykü gelişim çizgisi; kumpas; grafiğini çıkarma, çizgi, ekran görüntüsü içeren bir resim

Yapay zeka tarafından oluşturulmuş içerik yanlış olabilir.

**Figure 1.** ARIMA (5,1,0) model forecast vs actual daily demand (last year in dataset).

**4.3 Model Evaluation**

* **RMSE:** 895.46 MW
* **MAPE:** 4.74%

These metrics indicate strong forecasting performance, especially for long-term trend estimation.

**4.4 Scenario Analysis**

A 10% increase in energy demand during **January 2018** was simulated:

* Average January 2018 demand: **17,594.88 MW**
* Target demand with 10% increase: **19,354.36 MW**
* Additional capacity required: **1,759.49 MW**

This informs pre-season planning strategies for winter peaks.

**5. Conclusion**

This project successfully demonstrates how time series modeling can support data-driven decision-making in the energy sector. By forecasting demand and simulating extreme scenarios, energy firms can plan production, manage maintenance, and allocate resources more effectively.

**6. Future Work**

* Integrate temperature and seasonal features into a multivariate model.
* Apply SARIMA or Prophet models for improved seasonality tracking.
* Test real-time model accuracy with recent data.

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