

PowerPulse: Household Energy Usage Forecast

◆ Project Documentation

1. Project Overview

Title: PowerPulse: Household Energy Usage Forecast

Domain: Energy / Data Analytics / Machine Learning

Goal: To analyze and predict household power consumption patterns using time-series data, enhancing energy efficiency and enabling smart planning.

2. Data Description

- **Source:** Individual household electric power consumption dataset
 - **Columns:**
 - Global_active_power
 - Global_reactive_power
 - Voltage
 - Global_intensity
 - Sub_metering_1, Sub_metering_2, Sub_metering_3
 - Datetime (combined date & time column)
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3. Tools & Technologies Used

- **Python:** Data handling, modeling
 - **Pandas / NumPy:** Data manipulation
 - **Matplotlib / Seaborn / Plotly:** Visualization
 - **Scikit-learn:** Machine learning
 - **Streamlit:** Interactive dashboard
 - **VS Code / Jupyter Notebook**
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4. Methodology

Step 1: Data Understanding & Cleaning

- Handled missing values
- Converted and parsed datetime
- Resampled for granularity

- Removed anomalies

Step 2: Feature Engineering

- Created lag features (lag_1, lag_24h)
- Calculated other consumption (non-metered)

Step 3: Exploratory Data Analysis

- Distribution plots of energy usage
- Boxplots for sub-metering devices
- Correlation heatmaps

Step 4: Modeling

- **Model Used:** RandomForestRegressor
- Train-test split (50%)
- Hyperparameter tuning for memory optimization
- Evaluation metrics (RMSE, MAE, R^2)

5. Streamlit App Highlights

- Sidebar date filter
- EDA section with interactive plots
- Predictive modeling tab
- Performance metrics display
- Actual vs. Predicted visualization
- Optimized for low memory systems

6. Model Performance

Metric	Value
RMSE	~0.042
MAE	~0.006
R^2 Score	~0.998

7. Conclusion

- The forecasting model shows high accuracy and low error.

- Lag-based features significantly improve performance.
 - Streamlit enhances interpretability for stakeholders.
 - Potential to integrate real-time monitoring for smart homes.
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8. Future Enhancements

- Integrate real-time energy pricing
- Build LSTM-based deep learning model
- Deploy full-scale dashboard with alerts and recommendations

Project Done By: Bhuvanesh Thangaraj