Electric Vehicle Charging Demand Forecasting

Abstract

This project aims to forecast the hourly electricity demand at Electric Vehicle (EV) charging stations using historical energy usage, weather, and temporal data. Accurate demand forecasting enables charging station operators to optimize load distribution, reduce congestion, and improve operational efficiency. The model employs Facebook Prophet for time-series forecasting with added weather and calendar-based regressors for improved accuracy.

Introduction

The rising adoption of electric vehicles increases pressure on power grids, making demand prediction crucial for smart energy management. By analyzing temperature, precipitation, holidays, and hourly traffic-like patterns, this project provides a data-driven approach to estimate future energy needs at charging hubs. The insights are visualized in Tableau to guide policy and infrastructure planning.

Tools Used

1. Python - Data processing, feature engineering, and model building
2. Prophet - Time-series forecasting framework
3. Pandas & NumPy - Data manipulation and cleaning
4. Scikit-learn - Model performance evaluation (MAE, RMSE)
5. Tableau - Visualization of demand forecasts and heatmaps

Steps Involved in Building the Project

1. Data Preparation - Combined EV usage and weather datasets; extracted features like temperature, precipitation, hour, weekday, lag, and rolling averages.
2. Model Building - Trained a Prophet model with regressors and holiday effects to capture seasonality and external influences.
3. Forecasting - Predicted demand for the next 60 days on hourly basis.
4. Evaluation - Computed MAE and RMSE to validate accuracy.
5. Visualization - Exported forecast to Tableau for dashboard visualization of demand curves and heatmaps.

Conclusion

The project demonstrates a practical method for forecasting EV charging demand using time-series analysis.

The results can help optimize station scheduling, minimize load imbalance, and assist in energy distribution planning. Future improvements could include integrating real-time traffic and renewable generation data for enhanced precision.