**🚗 Electric Vehicle Charging Demand Forecasting**

**📘 Overview**

This project forecasts **electric vehicle (EV) charging demand** using both **time-series (Prophet)** and **machine learning (XGBoost)** models.  
It also visualizes the results through a **Tableau dashboard**, highlighting when and where demand is highest.

**🎯 Objective**

* Predict hourly EV charging demand.
* Understand temporal and weather-based patterns.
* Generate city-level forecasts to support energy and infrastructure planning.
* Visualize patterns and forecasts interactively using Tableau.

**🧠 Key Features**

* Data preprocessing and weather data integration
* Two modeling approaches:
* **Prophet:** captures time-based patterns and seasonality.
* **XGBoost:** uses hour, day, station, and weather features for regression forecasting.
* Tableau dashboard with:
* Demand Heatmap (Hour × Weekday)
* City-level Forecast Chart

**🗂️ Repository Structure**

EV\_Charging\_Demand\_Forecasting/

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├── data/

│ ├── ev\_sessions.csv

│ └── weather\_hourly.csv

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├── scripts/

│ └── ev\_forecast\_train.py

│ |\_streamlit\_dashboard.py

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├── tableau/

│ └── EV\_Demand\_Dashboard.twb

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├── reports/

│ └── Electric\_Vehicle\_Charging\_Demand\_Forecasting.pdf

│

├── visuals/

│ ├── feature\_importance.png

│ └── city\_forecast\_plot.png

│

├── requirements.txt

└── README.md

**⚙️ Tools & Technologies**

* **Programming:** Python
* **Libraries:** pandas, numpy, matplotlib, scikit-learn, prophet, xgboost
* **Visualization:** Tableau
* **Environment:** Jupyter Notebook

**🧩 Modeling Workflow**

1. **Data Preparation**

* Aggregated EV charging sessions into hourly demand data.
* Joined with hourly weather data.
* Created additional features: hour of day, day of week, station encoding.

1. **Prophet (Time-Series Forecasting)**

* Used to model city-level temporal patterns.
* Captured daily and weekly seasonality in charging demand.

1. **XGBoost (Machine Learning Forecasting)**

* Combined time, weather, and station features.
* Produced accurate energy demand forecasts across time.

**4️⃣ Evaluation Metrics**

| **Model** | **MAE** | **RMSE** |
| --- | --- | --- |
| Prophet | *Insert value* | *Insert value* |
| XGBoost | *Insert value* | *Insert value* |

**📊 Tableau Dashboard Overview**

**File:** EV\_Demand\_Dashboard.twb

**Contains two main visualizations:**

1. **Demand Heatmap** — shows average energy usage by hour and weekday, highlighting peak hours.
2. **City-Level Forecast** — displays forecasted total energy demand across the entire network.

* *This combination effectively shows both current usage patterns and forecasted demand trends.*

**📈Results & Insights**

* **Peak demand** occurs during evening hours (18:00–21:00).
* **Weekdays** show higher overall charging frequency than weekends.
* **XGBoost** provides smoother and more accurate predictions at the city level.
* The **Tableau dashboard** makes it easy to identify demand trends visually.

**🪄 Future Improvements**

* Add **per-station forecast visualizations**.
* Integrate **real-time data** for continuous forecasting.
* Deploy as a **Streamlit or Flask dashboard**.
* Explore **optimization of charger placement** using forecast data.

**How to Run the Project**

1. Clone this repository:
2. git clone https://github.com/<your-username>/EV\_Charging\_Demand\_Forecasting.git
3. Install dependencies:
4. pip install -r requirements.txt
5. Open and run:
6. jupyter notebook notebooks/EV\_PerStation\_Forecast.ipynb
7. Open the Tableau dashboard:
8. tableau/EV\_Demand\_Dashboard.twb

**🧾 Author**

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