EV Charging Load Forecasting

This presentation summarizes our data science analysis on EV charging load trends. We will cover charging behaviors, revenue insights, and predictive forecasts to inform infrastructure planning.

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Github: https://github.com/Harshver-16/EV-Project

Output Overview: EV Charging Load Forecasting Project

1. ## Charging Session Analysis

   Detailed look at energy consumption and user behavior patterns.

2. ## Revenue & Platform Behavior

   Insights into financial trends and user interaction with platforms.

3. ## Time-Based Patterns

   Understanding how usage varies by month and weekday.

4. ## Predictive Forecasting

   Forecasts for charging pile usage and EV charging volume.

5. ## Exploratory Visuals

   Key relationships between various data points.

6. ## Key Insights & Deliverables

   Summary of findings and project outputs.

Charging Session Analysis

Energy Consumption Distribution

- Most sessions deliver 4–7 kWh.
- Peak consumption is around 5 kWh.
- Few users consume over 15 kWh.

Most users top up their charge, not full charge. This suggests planning for medium-range demand.

Weekday Behavior

- Longest charging on Tuesdays and Thursdays.
- Weekends show shorter, fewer sessions.

This confirms workplace-based usage patterns. Infrastructure should align with these peak times.

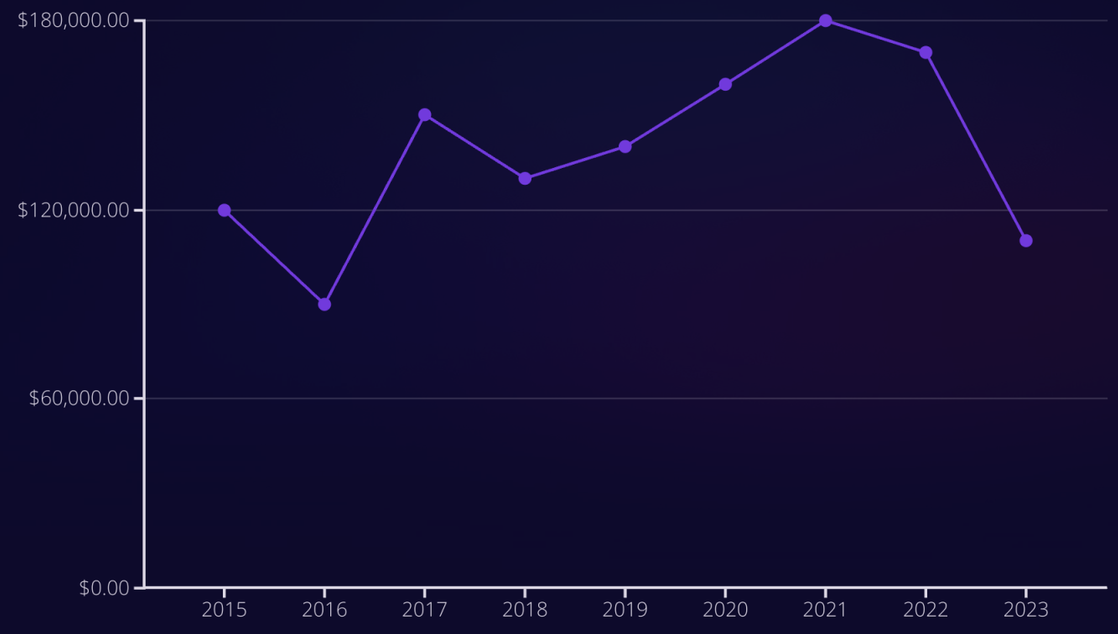
kWh by Day

- Weekday usage is stable and concentrated.
- Sunday has highest variability and outliers.

Sunday users tend to charge more. This may be due to longer trips or weekend activities.

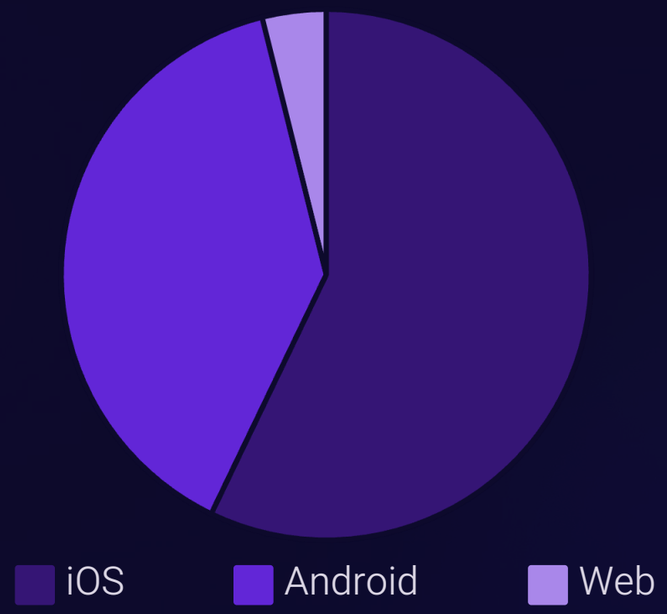
Revenue and Platform Behavior

Yearly Dollar Trend



Revenue peaks in 2015, 2017, and 2021, with dips in 2016 and 2023. This suggests policy changes or market demand shifts influenced trends.

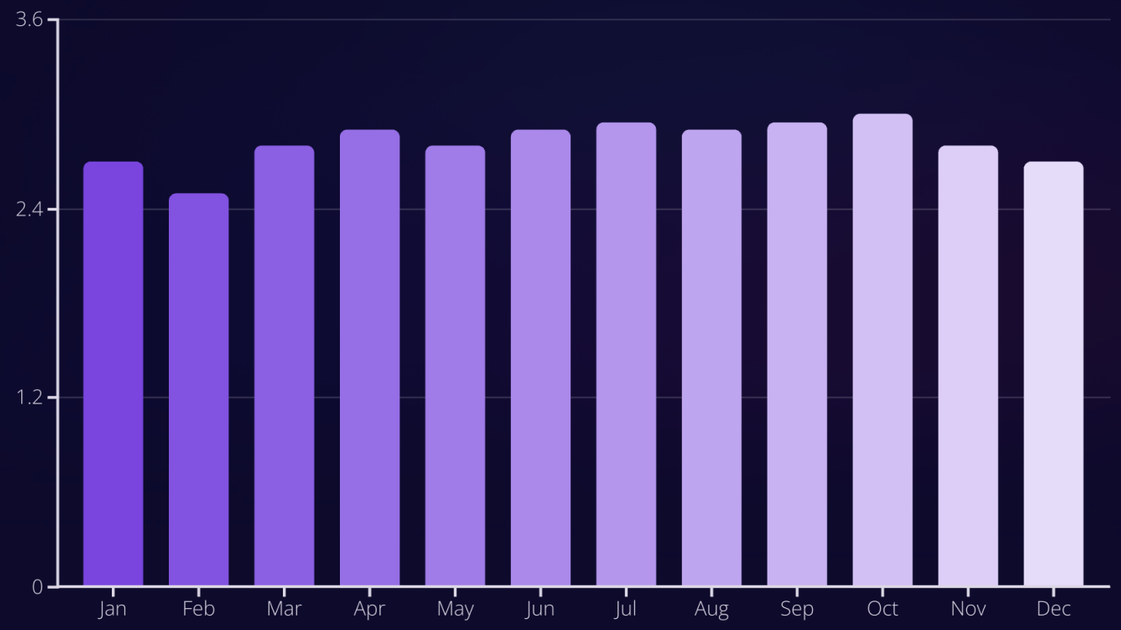
Platform Usage



iOS dominates with over 2,200 sessions, followed by Android. Web usage is minimal. A mobile-first design, especially for iOS users, is crucial.

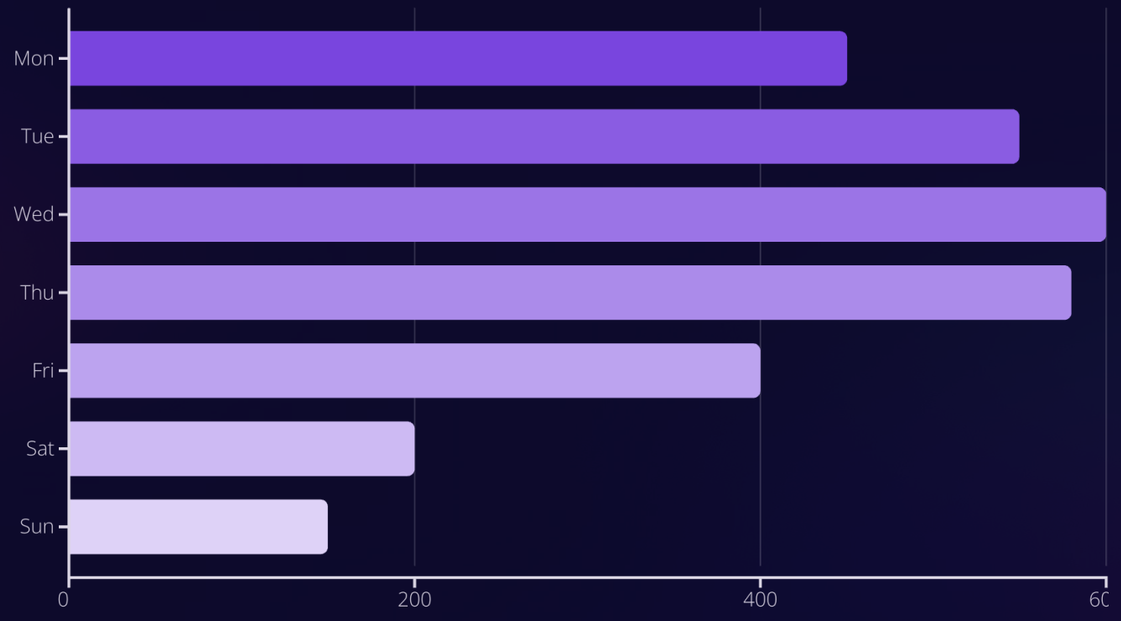
Time-Based Patterns

Average Charging Time by Month



October shows the highest average charging time (~3 hours). February has the lowest (~2.5 hours). This seasonal behavior may be linked to temperature or travel seasons.

Sessions by Weekday



Session counts are highest on Wednesday and Thursday. Weekends show a sharp decline, especially Sunday. This reinforces the observed workplace usage patterns.

Predictive Forecasting (Prophet Models)

Charging Pile Usage Rate

Slight downward trend, 2.50 to 2.42, over 48 hours. Peak hours are 10 AM and 8:30 PM. Usage is highly seasonal, with weekly peaks on Sunday and Friday.

Number of EVs Charging

Mostly 1–5 EVs charging at a time. Peaks align with usage rates. The count closely mirrors the usage trend, both showing a slight decline.

Prophet models indicate consistent, yet subtly declining, usage. Seasonality is a significant factor. Future forecasts should account for these trends.

Exploratory Visuals

kWh vs. Dollars

A noisy, yet positive, correlation exists. Many free sessions imply incentive programs are in place.

Energy Consumed by Vehicle Type

Some vehicle types consistently consume more energy. This may inform charger distribution.

Temperature vs Energy Consumed

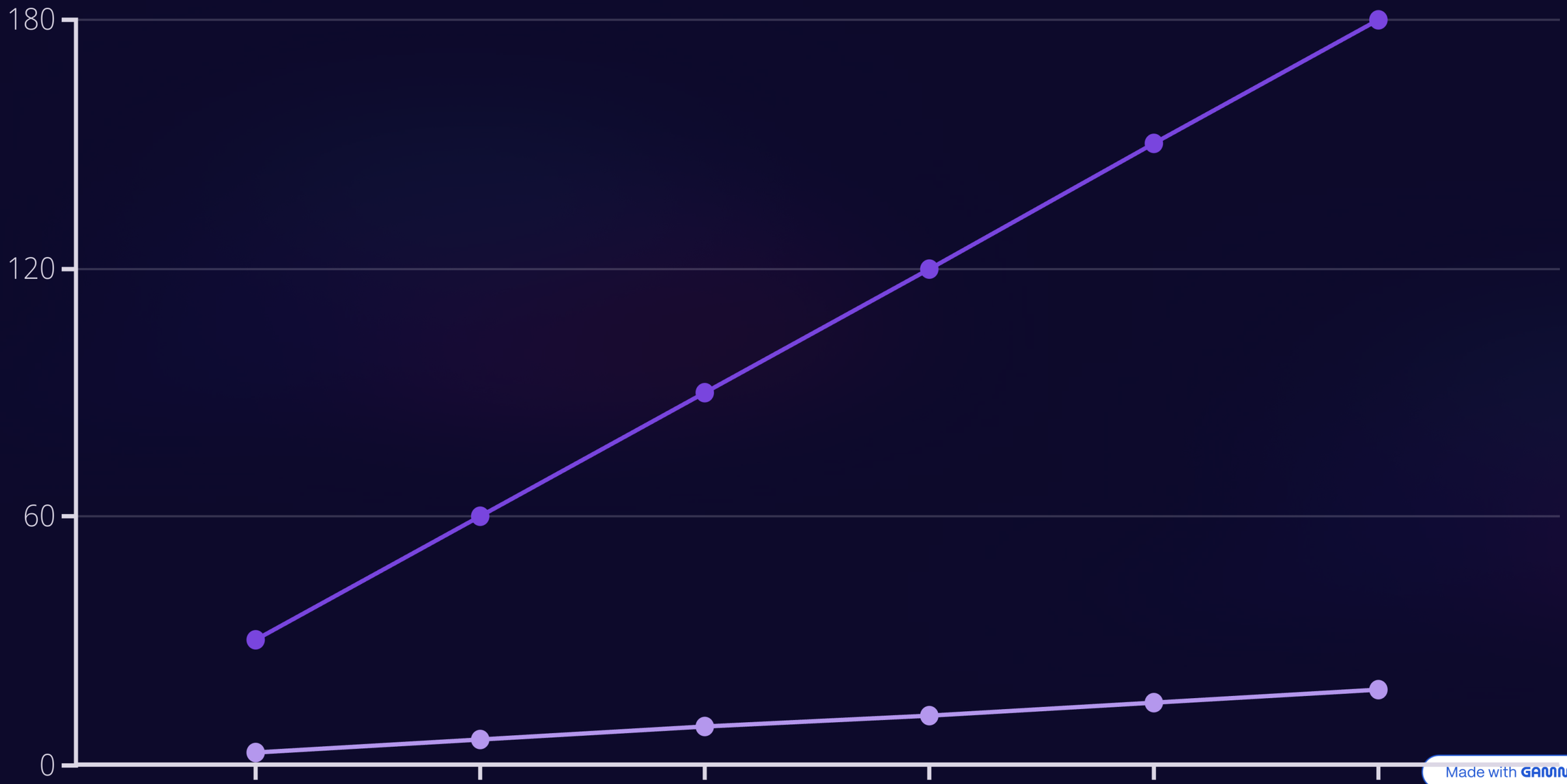
No clear pattern observed. Charging behavior is more driven by time than weather conditions.

Traffic Flow vs Energy

Energy use does not strongly depend on traffic intensity. This suggests driver patterns vary more.

These visuals provide nuanced insights into factors influencing EV charging. Time-based analysis remains most impactful.

Final Visual: Energy vs Charging Duration



Deliverables

Full PDF Report

Comprehensive insights and detailed charts.

Python Code

For preprocessing, EDA, and forecasting models.

Prophet Models

Time-series forecasts for two key metrics.

Cleaned Datasets

Station data and forecasting data.

These deliverables provide a complete package for understanding and utilizing the EV charging data.

Key Insights Summary

- **EV charging shows strong daily and weekly patterns**, peaking midweek and during business hours.
- **Charging durations and energy usage vary widely** by day and user group.
- **Forecast models reveal a slight decline** in both usage rate and number of EVs, with strong seasonality.
- **Recommendations include improving forecast granularity** by adding holidays and weather data, and refining count-based models for better accuracy.

These insights are crucial for optimizing EV infrastructure and operations.