Predicting EV Charging in Apartment Buildings

Introduction

In a world moving towards sustainability, as traditional fuel resources depleting and environmental worries grow, there is a notable shift towards electric solutions. More individuals are opting for electric vehicles (EVs), and countries are actively planning to fully embrace the reliance on EVs for a more sustainable future.

Problem Statement

Challenges of energy consumption and load prediction in the context of residential electric vehicle (EV) charging in apartment buildings

Dataset

Residential EV Charging Data

What does the Data look like:

Dataset 1: EV charging reports

Dataset 2: Hourly EV charging loads and idle capacity, for all sessions and users individually

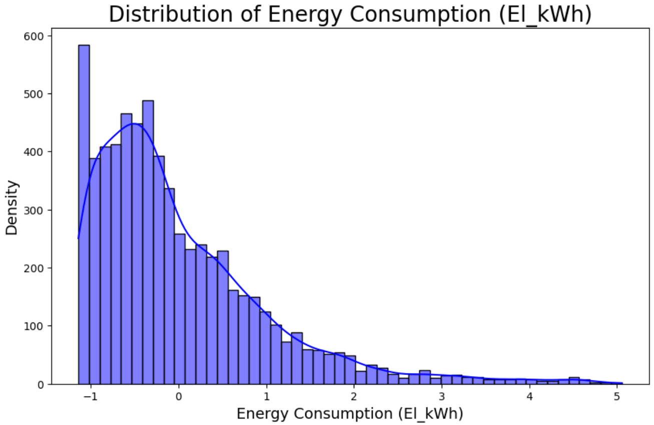
Dataset 3 and 4: Hourly EV charging loads and idle capacity, aggregated for private or shared CPs

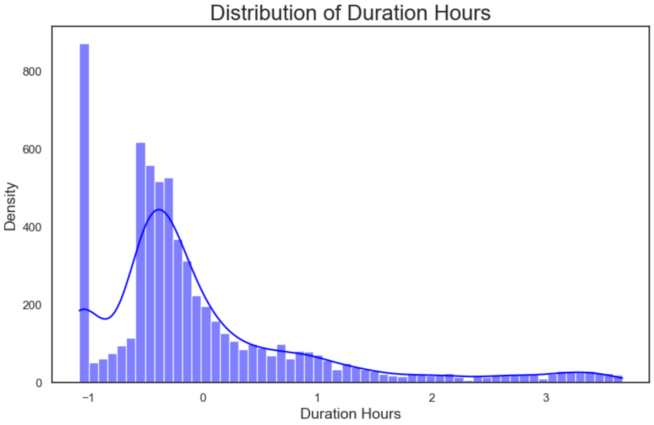
Dataset 5: Hourly smart meter data from garage Bl2

Dataset 6: Local traffic density

Dataset 7: Weather Data

EDA



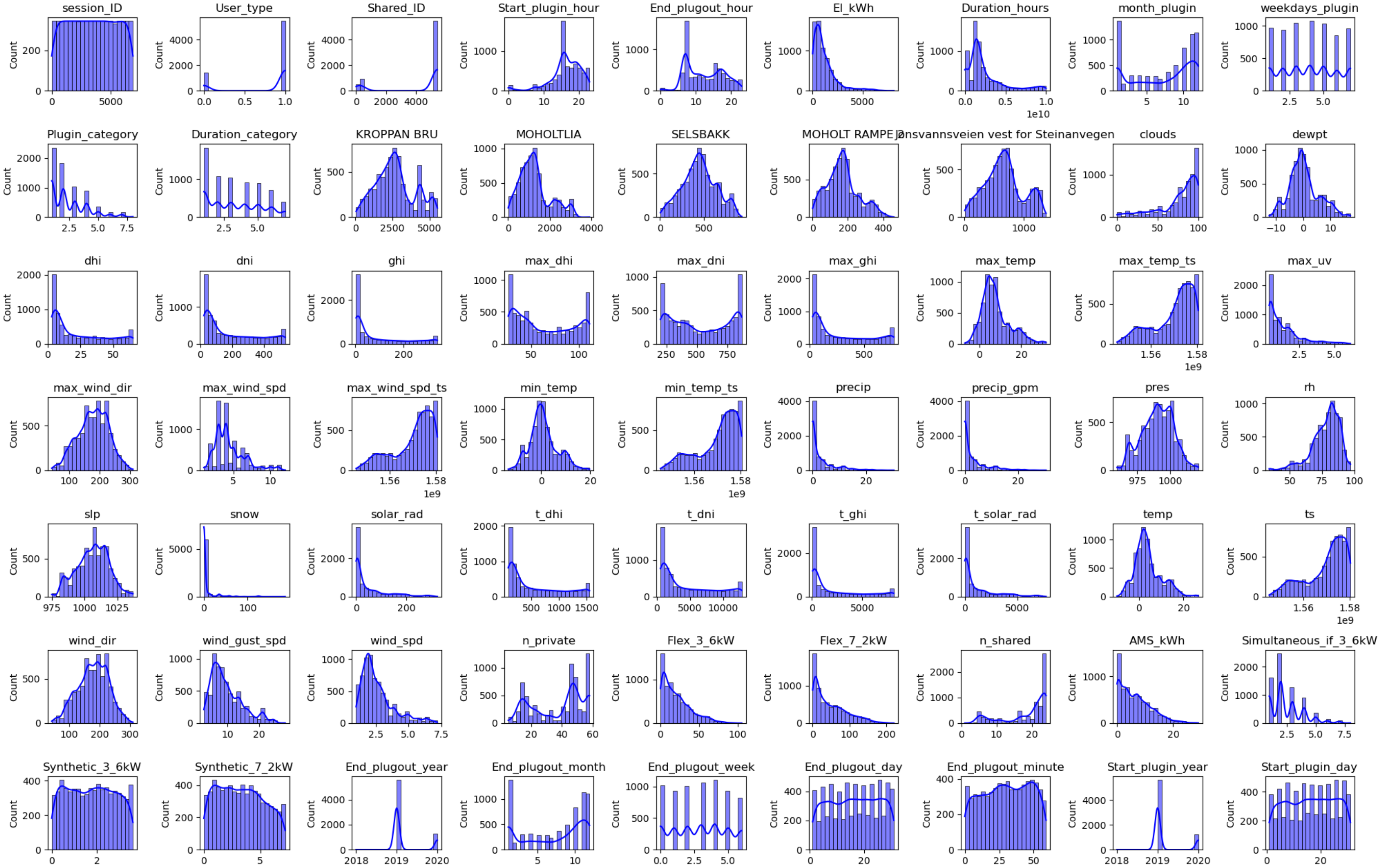


Target Variable

The amount of electrical energy consumed, measured in kilowatt-hours (kWh)

Independant Feature

Is the amount of time that a vehicle is connected to a charging statio to replenish its battery


session_ID
User_type
Shared_ID
Start_plugin_hour
End_plugout_hour
El_kWh
Duration_hours
month_plugin
weekdays_plugin
Plugin_category
Duration_category
KROPPAN BRU
MOHOLTLIA
SELSBAKK
MOHOLT RAMPE 2
Jonsvannsveien vest for Steinanvegen
clouds
dewpt
dhi
dni
ghi
max_dhi
max_dni
max_ghi
max_temp
max_temp_ts
max_uv
max_wind_dir
max_wind_spd
max_wind_spd_ts
min_temp
min_temp_ts
precip
precip_gpm
pres
rh
slp
snow
solar_rad
t_dhi
t_dni
t_ghi
t_solar_rad
temp
ts
wind_dir
wind_gust_spd
wind_spd
n_private
Flex_3_6kW
Flex_7_2kW
n_shared
AMS_kWh
Simultaneous_if_3_6kW
Synthetic_3_6kW
Synthetic_7_2kW
End_plugout_year
End_plugout_month
End_plugout_week
End_plugout_day
End_plugout_minute
Start_plugin_year
Start_plugin_day
Count

Feature Engineering

Techniques

Date and Time Features:
- Hour/day/week/month/year

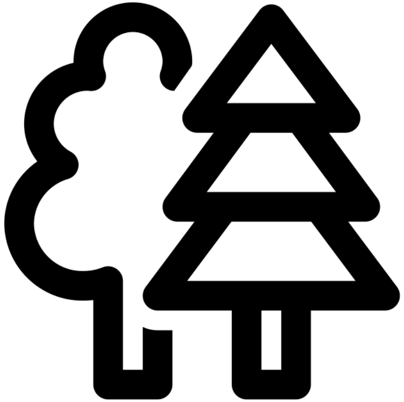
Feature Scaling:
- Standardization or normalization of numerical features

Outlier Handling:
- Identification and handling of outliers

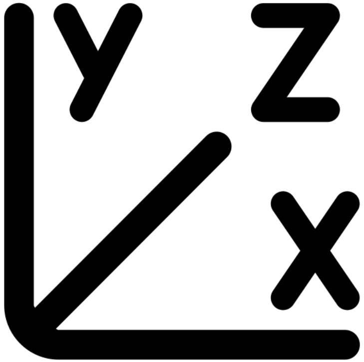
Missing Data Handling:
- Imputation or removal of missing data

Encoding Categorical Variables
- Utilized one-hot encoding

Baseline Models



Random Forest Regressor



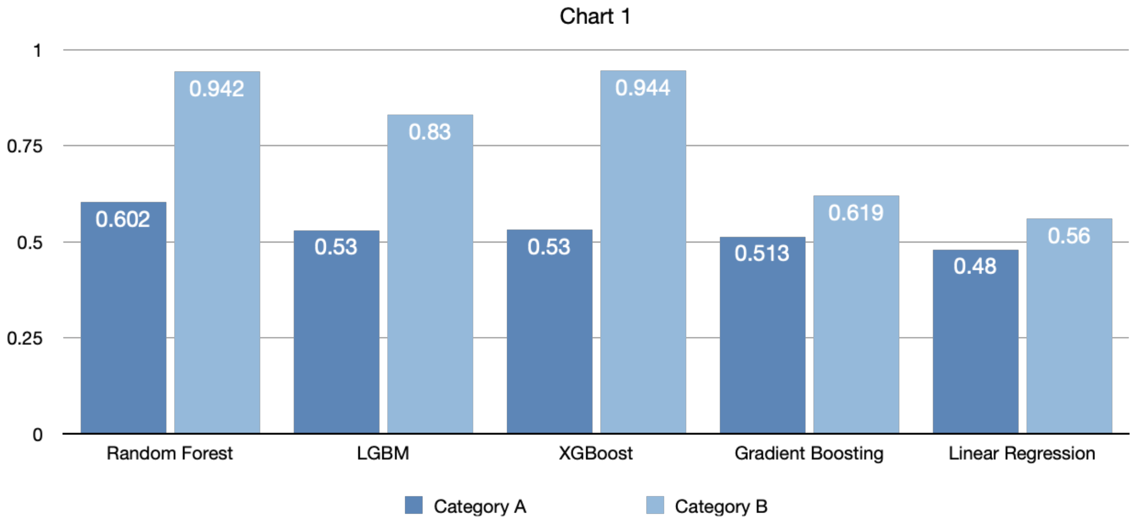
Linear Regression

Gradient Boosting Regression

Baseline Models Comparison

Results

Random Forest has both the highest R-squared (R2) score on validation and train set , it strengthens the evidence in favor of its performance.



Results interpretation

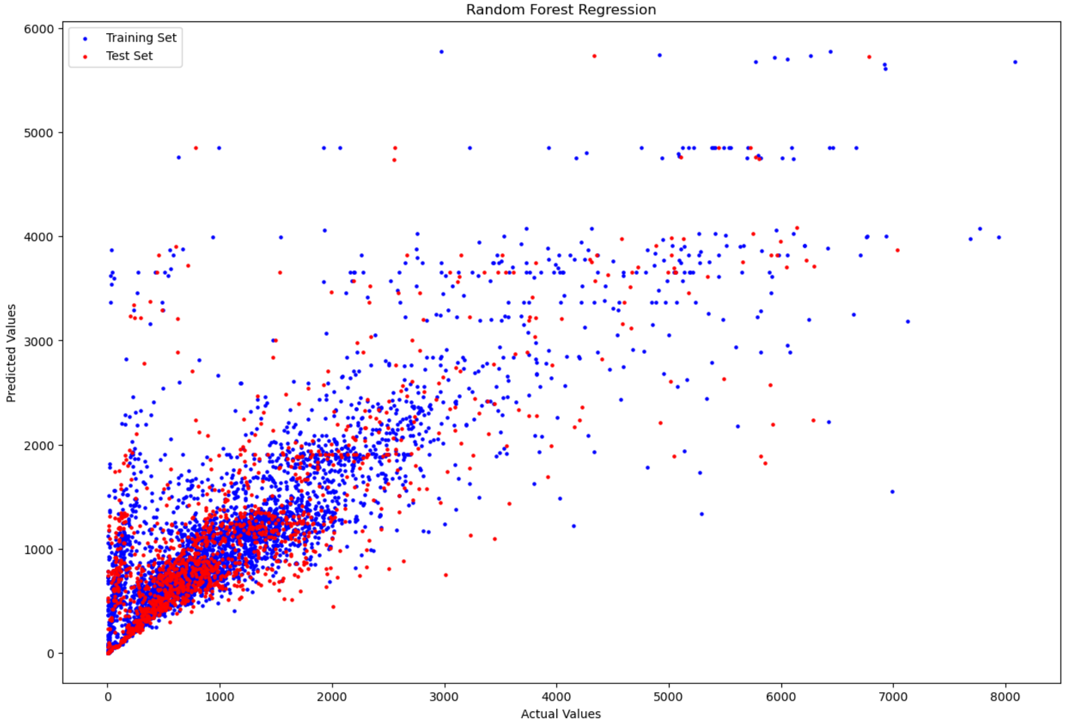
- Non-Linear Patterns:
- High Feature Correlation:
- Multicollinearity Mitigation:
- Robust Against Outliers:

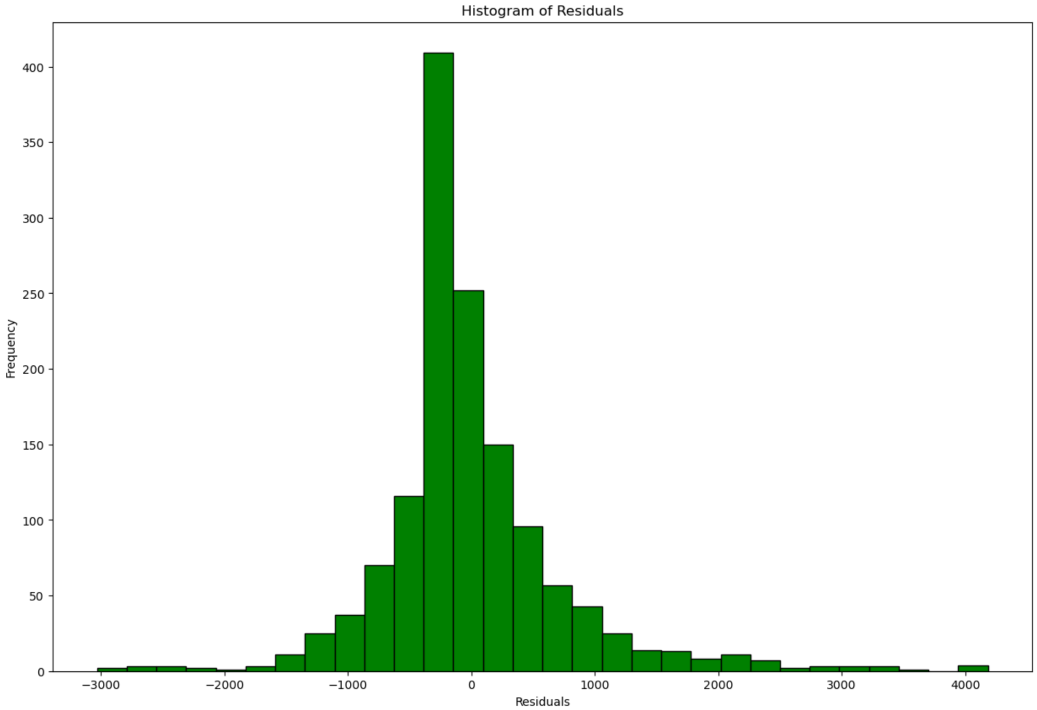
Random Forest Regression Model Results

The scatter plot visually examines the model's predictions on the test and validation sets. The proximity of points to the diagonal line reflects the alignment of predictions with the actual values. R-squared (R2) scores of 0.61 for the Test set and 0.70 fo the Train set indicate a reasonably strong fit, capturing substantial portion of the variance in both datasets.

Conclusion:

The outcomes from the random forest regression mode suggest that approximately 56-57% of the features effectively predict energy consumption.





Residuals

Observation:

- The residuals are spread relatively evenly across the range of predicted values, it suggests homoscedasticity.
- The errors are normally distributed.
- The residuals that are centered around zero represent a well-fitted model.
- Outliers in the residuals may indicate data points that the model is not capturing well. Will need to be investigated.

Conclusion

Firstly, at a societal level, optimizing energy consumption in residential EV charging can contribute to overall energy efficiency and sustainability.
From a business standpoint, property managers and energy providers can gain from implementing efficient energy management, leading to reduced costs, optimized infrastructure investments, and an improved charging experience for EV users.

Next Step:

Go back to EDA
Feature Engineering
Model Evaluation and Fine-Tuning
Deeplearning models
Reinforcement learning to optimize energy consumption

A quote

“If you torture the data long enough, it will confess to anything”

Ronald Coase