US Electric Car Registrations & Renewable Energy Production

This document provides a complete, structured solution to the Data Analytics Capstone project. The analysis explores electric vehicle (EV) adoption trends in the United States and their relationship with renewable energy production.

1. Data Collection

Datasets include EV registrations by state and year, electricity generation by source (solar, wind, hydro, fossil fuels, and nuclear), and state code reference tables. Data sources include the U.S. Energy Information Administration (EIA) and transportation departments.

2. Data Cleaning & Preprocessing

Data preprocessing involved removing duplicates, handling missing values using interpolation and median imputation, standardizing state names, converting date columns to datetime format, and aggregating monthly data into yearly summaries.

3. Exploratory Data Analysis (EDA)

EDA revealed that EV registrations are highly right-skewed, with California leading adoption by a wide margin. Renewable energy production varies significantly across states, with wind dominating in the Midwest and solar in the Southwest.

4. Correlation Analysis

Pearson correlation analysis shows a moderate to strong positive correlation between EV registrations and renewable energy production, especially solar and wind energy. Fossil fuel generation showed weak or negative correlation with EV adoption.

5. Time Series Analysis

Time series analysis indicates a strong upward trend in EV adoption post-2016, with acceleration after 2020. Renewable energy production also shows consistent long-term growth, particularly in solar generation. Seasonal effects are minimal in yearly aggregated data.

6. Geospatial Analysis

Geospatial mapping highlights higher EV adoption in coastal states and states with strong renewable energy infrastructure. California, Washington, and New York emerge as leaders in both EV adoption and clean energy use.

7. Predictive Modeling

Linear Regression and Random Forest models were used to forecast EV adoption. Renewable energy production, population, and income levels were key predictors. The Random Forest model achieved superior performance with lower RMSE and higher R^2 values.

8. Policy Impact Assessment

States offering EV tax credits, rebates, and charging infrastructure investments show significantly higher EV adoption rates. Federal incentives have accelerated national adoption, while inconsistent state policies remain a barrier in some regions.

9. Conclusion & Recommendations

The analysis confirms a strong relationship between renewable energy growth and EV adoption. Policymakers should expand renewable investments, standardize EV incentives across states, and prioritize charging infrastructure. Industry stakeholders should focus on renewable-powered charging networks to support sustainable transportation.