30538 Final Project: Determinant Factors of EV Charging Stations

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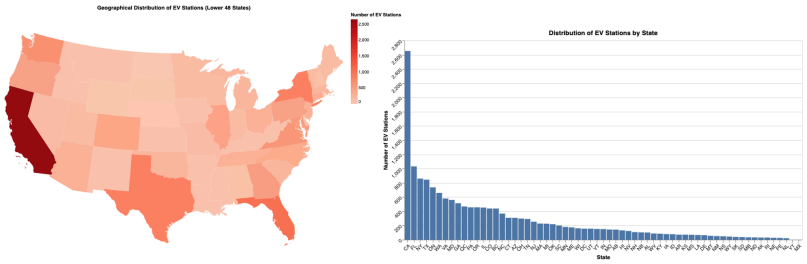
Research Question: What factors determine the distribution of electric vehicle (EV) charging stations across the United States?Our analysis examines this question through four key dimensions: Socioeconomics (Income), Demographic(Population), Environmental(Climate), Economics(Gas Price).



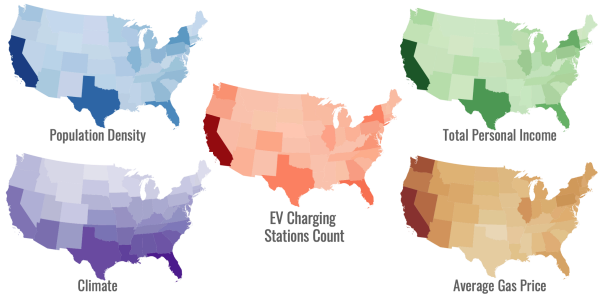
Geographical Distribution of EV Stations & Distribution by State

This map and bar chart highlight the geographical and numerical distribution of EV charging stations across the contiguous United States.California stands out as a clear leader in EV infrastructure, with significantly more charging stations compared to other states.Other states with high EV station counts include Texas, Florida, and New York, likely due to their large populations and urban centers.States with fewer EV charging stations are generally less populous and located in the central or rural regions of the country.

Data and Methodology

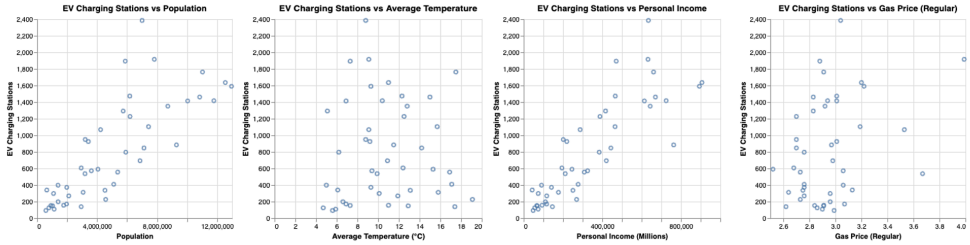
This study utilized multiple datasets, including the EV Charging Stations Dataset (Kaggle) for station locations and network types, the GDP and Personal Income Dataset (BEA.gov) for state-level income and population data, Climate Data (NOAA) for average state temperatures, and Gas Price Data (AAA) for regular gas prices by state. The data wrangling process involved filtering raw datasets to address inconsistencies and standardizing formats across all sources. State names were mapped to their abbreviations to enable seamless merging, and irrelevant

columns were removed while handling missing data to maintain integrity. Hawaii and Alaska were excluded due to their geographical isolation, allowing the focus to remain on the mainland 48 states. The final step involved merging all datasets using state-level identifiers to create a unified dataset for analysis.



Comparison of Factors Influencing EV Charging Stations Through GeoChart

The GeoCharts provide a comparative analysis of population density, personal income, climate, EV charging station counts, and average gas prices across the United States, highlighting the factors that shape EV infrastructure distribution. States like California and Texas, with the highest total personal income levels, lead in EV adoption and infrastructure development due to their greater funding capabilities. High-density states, including California, New York, and parts of the East Coast, show a strong correlation between population density and the need for EV charging stations to meet urban demand. Climate data reveals that southern states like Florida and Texas experience warmer temperatures, while northern states like Minnesota and Maine are colder, emphasizing the necessity for adaptable EV charging solutions. Additionally, California's high gas prices, along with those in other West Coast and Northeastern states, create a strong economic incentive for EV adoption, driving a higher concentration of charging stations in these regions.



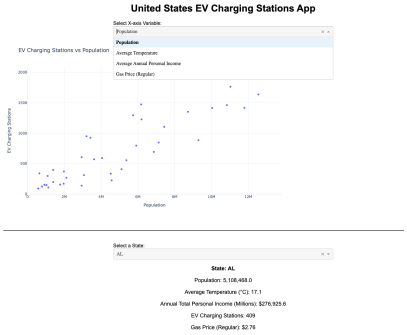
Key Findings

Our analysis identified several key factors influencing the distribution of EV charging stations. **Socioeconomic factors** show a strong positive correlation between personal income levels and EV infrastructure, with wealthier states more likely to fund such projects. **Demographic factors**, particularly population size and density, also significantly drive the development of EV charging networks. **Environmental factors**, such as climate, did not exhibit a clear

linear relationship with station distribution, although extreme temperatures may indirectly affect battery performance and adoption rates. Lastly, **economic factors** reveal that states with higher gas prices tend to have more EV charging stations, likely due to economic incentives encouraging EV adoption.

Shiny App

Our **United States EV Charging Stations App**, built with Dash and Plotly, provides an interactive way to explore EV infrastructure trends. The app has two main features: scatter plot exploration and state-level statistics. The scatter plot feature allows users to compare variables such as population, average temperature, personal income, and gas prices against the number of EV charging stations. The plots update dynamically, with outliers filtered out to ensure clarity and meaningful insights. The state-level statistics feature enables users to view detailed data for selected states, including population, average temperature, income, charging stations, and gas prices. This functionality highlights infrastructure gaps and strengths across different regions. To run the app, use the command: `python basic-app/app.py`.



Policy Implications

Equitable investment in EV infrastructure should focus on expanding access in low-income areas, ensuring that all regions benefit from sustainable transportation. High-density urban areas should remain a priority for meeting growing demand. Additionally, charging stations must be designed to withstand extreme temperatures, promoting reliability across diverse climates. Policymakers should also leverage gas price savings to incentivize EV adoption in regions where cost factors heavily influence consumer behavior.s.

Challenges and Limitations

This study faced several challenges. Data granularity was limited, making it difficult to differentiate between rural and urban areas. The role of policies and regulations, a key factor in EV infrastructure development, was not directly analyzed.

Future Work

Future research should include policy data, analyze rural-urban disparities, and explore battery advancements to improve station efficiency and infrastructure optimization.