Electric Vehicle Data Visualization

Hongyi Wang, Yuchong Chen, Yingkai Zhong, and Nan Jiang

University of Southern California, Los Angeles, CA 90007, USA
{hongyiwa, yuchongc, yingkaiz, njiang72}@usc.edu

Abstract. The electric vehicle (EV) industry has witnessed unprecedented growth, reshaping the automotive technology landscape. This paper presents a comprehensive data visualization project that addresses the informational needs of key stakeholders in the EV sector in the Washington State: investors, potential EV purchasers, and policymakers. Our project offers a detailed analysis of the EV market, including market share, brand performance, and geographical distributions. The project also provides insights into the growth of EV adoption, the comparative analysis of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs), and the distribution of electric range, enabling informed decision-making for stakeholders.

Keywords: Electric Vehicle · Data Visualization · Washington State.

1 Introduction

The electric vehicle industry is at the forefront of a significant transformation in automotive technology, driven by rapid growth and increasing consumer interest. This paper introduces a data visualization project designed to serve as a valuable resource for EV industry investors, potential EV purchasers, and policymakers.

Our approach involves a step-by-step analysis of different data visualizations. Users can track the progression of EV adoption through a line chart. A stacked bar chart presents the quarterly changes in BEV and PHEV registrations. Additionally, a choropleth map enables investors to identify investment hotspots in the Washington State. Finally, the distribution of electric range is analyzed.

2 Related Work

The electric vehicle landscape in Washington State presents a unique and rapidly evolving market, as evidenced by recent research and data [4]. As of July 2023, Washington boasts 104,050 all-electric vehicle registrations, ranking fourth in the nation behind California, Florida, and Texas. This high number of registrations is particularly notable when normalized for population, with Washington having 14.5 plug-in PEVs per 1,000 people, a figure that surpasses California when adjusted for population density.

3 Data

We used 2 datasets in the project. Namely, Electric Vehicle Population Data [2] and Electric Vehicle Population Size History By County [3]. Both datasets were obtained from the State of Washington website, which was provided by the government administration.

3.1 Electric Vehicle Population Data

The Electric Vehicle Population Data dataset shows the BEVs and PHEVs that are currently registered through Washington State Department of Licensing (DOL). The dataset has 159K rows and 17 attributes. Each row represents a vehicle. From this dataset, we are able to know detailed information about each vehicle registered. For example, we can obtain location information from the county and coordinate columns. The dataset also contains information about vehicles, such as model, year, make, vehicle type (BEVs or PHEVs), and electric range that can be visualized to convey insightful messages.

3.2 Electric Vehicle Population Size History By County

Electric Vehicle Population Size History By County dataset shows the number of vehicles that were registered by Washington State DOL each month. It contains data from January 2017 to October 2023. It has 19.4K rows and 10 attributes. Each row is a monthly count of vehicles for a county. The data distinguishes EVs and non-EVs as well as BEVs and PHEVs. This dataset has time-series identities that can be visualized in a variety of forms regarding different vehicle types.

4 Approach

4.1 Preprocessing

We mainly used the pandas package to preprocess the datasets. For Electric Vehicle Population Dataset, rows with missing values in any column were identified and dropped. The "Vehicle Location" column was converted into two separate columns "Latitude" and "Longitude", and both columns were set to a decimal format. The "Postal Code", "2020 Census Tract", and "Legislative District" columns were set to the integer format.

For Electric Vehicle Population Size History By County Dataset, an exploratory data analysis (EDA) was conducted. Rows with missing values in the 'County' and 'State' columns were identified and removed. The 'date' column was then converted to a datetime format for consistency and ease of analysis. The 'Electric Vehicle (EV) Total' was validated to ensure it was the sum of BEVs and PHEVs. No discrepancies were found.

4.2 UI Design

Our web app features a user-friendly interface that allows users to gain insights and seamlessly explore the data. We established a visualization wheel 1 as a guiding framework throughout the project.

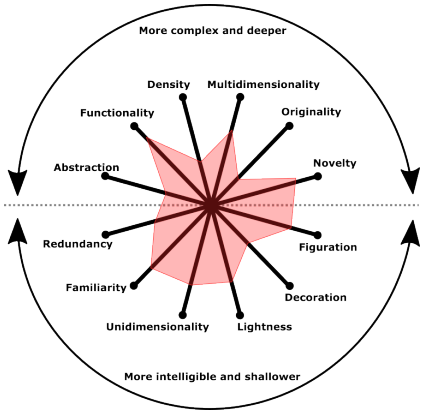

Fig. 1. The reference visualization wheel for the project.

Landing Page We developed an engaging landing page featuring a concise introduction to the website along with a dot map showcasing the registered locations of electric vehicles across Washington State. This visualization provides a comprehensive overview of the electric vehicle landscape, catering to the interests of electric vehicle customers, investors, and policymakers, enabling them to grasp the broader scope of electric vehicle distribution.

Dashboard We developed a comprehensive dashboard providing in-depth data analysis insights for EV customers, investors, and policymakers:

- The KPIs provide users with a comprehensive overview of the EV landscape, encompassing the total count of electric vehicles and their ratio within the entire vehicle population.
- The line chart illustrates a prominent increasing trend in EV adoption from 2017 to 2023, offering users a clear insight into the growth pattern over time.
- The donut chart showcases the proportion of two types of EVs, notably emphasizing that BEVs constitute a significant majority within the EV population.
- The bar chart detailing the top 10 EV brands vividly displays the market share distribution among the leading EV manufacturers, revealing significant insights into the competitive landscape and market positioning within the industry.

– The corresponding pie chart representing EV makes further emphasizes the market distribution, offering a nuanced view of the diverse range of EV manufacturers and highlighting Tesla's dominance, with Tesla holding more than half of the market share among electric vehicle manufacturers.

Overview The line chart shows that EV population with a consistent upward trajectory. This upward trend suggests a growing adoption of EVs. The non-EV population initially increased but showed fluctuations over time, ultimately decreasing and dropping below the 2017 level by 2023. Investors can use this data to make informed decisions about investing in EV manufacturing companies. Policymakers can plan for and invest in EV charging stations, grid upgrades to support increased electricity demands.

EV Trend The stacked bar chart demonstrates the number of BEVs and PHEVs vehicles registered in Washington every season from 2017 to 2023. BEVs are powered entirely by electricity, while PHEVs are powered by both fuel-based internal combustion engines and rechargeable electric motor. The data are aggregated by summing up the count in each month to quarters to easier to visualize. From the chart, there is an increase trend every quarter with an even stronger pace quarterly. The BEV's adoption is much stronger than the PHEVs. Based on the trends and insight, investors may come up with a strategy on focusing more popular market that has more undiscovered potential. Purchaser will be evaluating their choices based on the popularity and the potential price changes reflected by the demand of each type.

Map We present a choropleth map illustrating the geographical distribution by county in Washington state. A notable concentration around the metropolitan area of Seattle is evident, highlighted by King County as a focal point. This visualization provides insights into the spatial distribution of electric vehicle ownership, especially in metropolitan regions. The choropleth map assists policymakers and investors in strategic infrastructure planning, directing attention towards areas with higher electric vehicle densities for targeted development efforts. Complementing this visualization, a detailed table below offers specific counts and proportions across counties. This combined analysis assists stakeholders in making informed decisions regarding infrastructure development and resource allocation to meet the growing demand for electric vehicles.

Electric Range The histogram effectively displays the distribution of electric ranges for two types of electric vehicles: BEVs and PHEVs. The electric range, defined as the distance a vehicle can travel exclusively on electric power, is an important metric for understanding these vehicles' capabilities. BEVs typically exhibit a significantly higher average electric range than PHEVs. Conversely, PHEVs show a more confined range distribution. Such insights are invaluable for potential EV buyers, guiding them in choosing a vehicle type that aligns with

their typical driving distances and charging habits. Furthermore, this data offers policymakers valuable guidance in developing infrastructure to accommodate and encourage the adoption of electric vehicles in urban and other areas.

Dataset We offer an interactive page featuring two tables, enabling users to delve deeper into the dataset. These tables facilitate exploration by allowing users to sort data dynamically through column headers or filter information using a search bar. This interactive interface provides an efficient means for users to interact with the dataset, enhancing the accessibility and usability of the dataset for comprehensive exploration and analysis.

5 System

For comprehensive design consistency across our web pages, we opted for Bootstrap to ensure a cohesive and user-friendly interface. Specifically for data visualization, our toolset comprised Mapbox for the creation of diverse maps, including a dot map and a choropleth, enabling a multifaceted exploration of geographical data. In addition, we harnessed the power of d3.js [1], chart.js, and simple data tables libraries to craft visually engaging and informative graphs that provide a detailed understanding of the electric vehicle landscape.

6 Conclusion

In conclusion, this paper presents a comprehensive data visualization project that significantly enhances the understanding of the EV market in Washington State. Through meticulous data preprocessing and an intuitive user interface design, the project offers a multifaceted view of the EV landscape. The dashboard, line charts, bar charts, choropleth maps, and histograms, provide valuable insights into EV adoption trends, market shares, and geographical distribution. This tool is not only beneficial for investors, who can strategize based on market trends but also for potential EV buyers and policymakers. Buyers can make informed decisions based on vehicle types and their capabilities, while policymakers can utilize this data for effective urban and infrastructure planning. This paper underscores the importance of data visualization in understanding and navigating the rapidly evolving landscape of electric vehicles.

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