Project Report - Electric Vehicle Population Data

Big Data, Section C Fall 2024

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Abstract

As the aim of the project, we intend to research into and analysis the electric vehicle population in Washington State and present a study about insights received. The following sections of this proposal explain in detail the problem statement, objectives, data source and information, technologies, and programming language.

Problem Statement and Objectives

Electric vehicles (EVs) have seen significant growth in recent years. In 2023, nearly one in five cars sold globally was electric, with sales reaching almost 14 million [1]. This represents a 35% increase from 2022 and is more than six times higher than in 2018 [2].

This project aims to analyze the dataset of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) registered through the Washington State Department of Licensing (DOL). The analysis will focus on understanding the preference, geographic distribution, and types of these vehicles. Additionally, the project will evaluate environmental impact based on scientific estimation.

Inspired by this scenario, we intend to create an analysis to answer:

1. Identify and analyze the composition of EV population in Washington State, including:
    a. Manufacturer
    b. Energy Utility
2. The best-selling model of each brand
3. The best-selling model / brand of each EV type

4. The best-selling vehicle in WA
5. The best-selling vehicle in each city (WA)
6. The best-selling vehicle in each country (WA)
7. Most favorite brand in WA
8. Most favorite brand in each city (WA)
9. Most favorite brand in each country (WA)
10. Map the geographic distribution of BEVs and PHEVs across different counties and cities in Washington State
11. Identify regions with high and low adoption rates and investigate contributing factors
12. Estimate the reduction in CO2 emissions and fuel consumption due to the adoption of BEVs and PHEVs

Technology

a. Microsoft Excel
b. Jupyter Notebook
c. Tableau
d. Python
e. SQL Language

Project Composition

a. Jupyter Notebook Scripts
b. Tableau Workbooks
c. Dataset

Code Execution Instructions

Readme: EV-Data-Analysis/README.md at main · Shadows2049/EV-Data-Analysis

a. For Jupyter Notebook Scripts, upload and execute in Jupyter Notebook; upload dataset and modify the relevant path accordingly.
b. For Tableau Workbooks, open and execute in Tableau.

Technology Challenges

During the course of our project, we encountered several technological challenges that required innovative solutions and collaborative efforts to overcome.

Our project required the integration of various technologies, including Microsoft Excel, Jupyter Notebook, Tableau, Python, and SQL. Coordinating these tools to work seamlessly together was a significant challenge. We overcame this by establishing a clear workflow and using Jupyter Notebook as the central platform for data analysis. Python scripts were used to preprocess data and perform initial analysis, while Tableau was employed for complex and interactive data visualization. SQL was used for calculation in Tableau to manage and query the dataset efficiently. By clearly defining the roles of each technology and ensuring smooth data flow between them, we were able to integrate these tools effectively.

Mapping the geographic distribution of BEVs and PHEVs across different counties and cities in Washington State was another challenge. Tableau was instrumental in creating interactive maps, but we faced difficulties in accurately representing the data due to geographic boundaries and varying data granularity. To overcome this, we used optimized conditions and filters to ensure that our data was accurately mapped. We also customized the visualizations to highlight regions with high and low adoption rates in density map, providing clear insights into the geographic distribution of electric vehicles.

In conclusion, the technological challenges we faced during this project provided valuable learning experiences and opportunities for innovation. By leveraging a combination of advanced tools and techniques, collaborating effectively as a team, and maintaining a focus on data integrity and accuracy, we were able to overcome these challenges and achieve our project objectives. The successful completion of this project has not only enhanced our technical skills but also prepared us to tackle similar challenges in future endeavors.

Future Improvements

As we reflect on the Electric Vehicle Population Data project, several areas for future improvements have been identified to enhance the depth and breadth of our analysis.

To provide a more comprehensive analysis, we could integrate additional data sources. This could include data on charging station locations, electricity consumption rates, and demographic information. By incorporating these datasets, we can gain deeper insights into the factors influencing electric vehicle adoption and usage patterns.

Implementing more advanced analytical techniques, such as machine learning algorithms, could improve our ability to predict trends and identify patterns in the data. For example, clustering algorithms could help identify regions with similar adoption rates, while regression models could predict future growth in electric vehicle populations based on historical data.

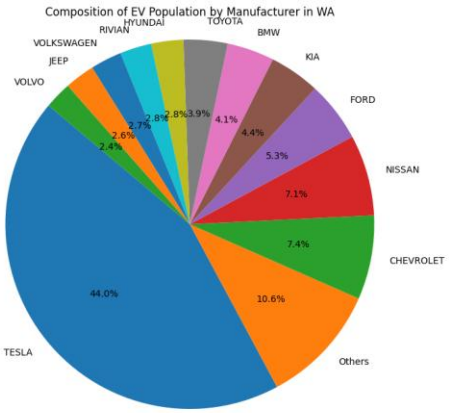
Improving our data validation processes could ensure the accuracy and reliability of our analysis. This could involve implementing automated validation checks, developing more robust error-checking algorithms, and conducting regular audits of our data sources.

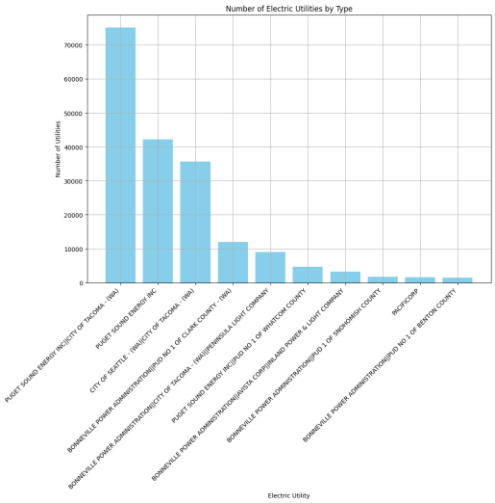
Expanding our environmental impact analysis to include additional metrics, such as air quality improvements and reductions in greenhouse gas emissions, could provide a more holistic view of the benefits of electric vehicle adoption. This could involve collaborating with environmental scientists to develop more accurate models and methodologies.

By addressing these areas for improvement, we can enhance the value and impact of our Electric Vehicle Population Data project, providing more comprehensive insights and supporting the continued growth and adoption of electric vehicles.

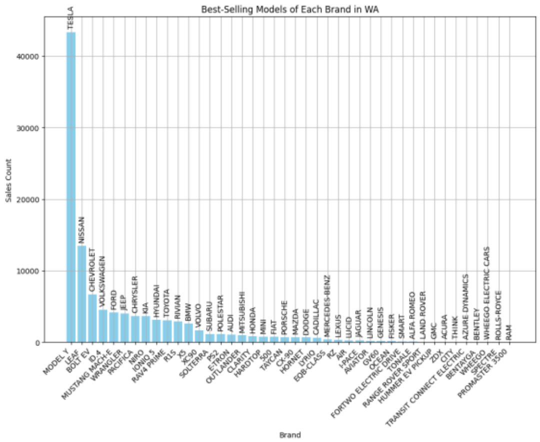
Results

1.

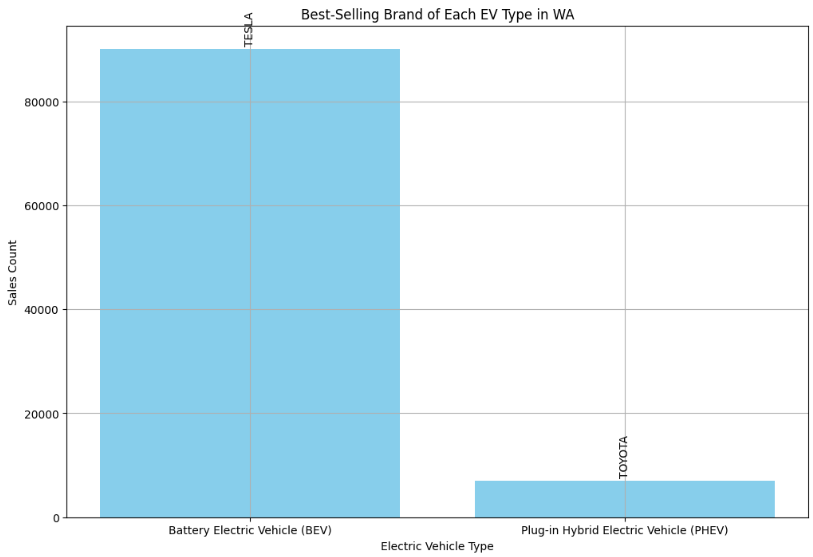

Composition of EV Population by Manufacturer in WA
TESLA
44.0%
Others
10.6%
CHEVROLET
7.4%
NISSAN
7.1%
FORD
5.3%
KIA
4.4%
BMW
4.1%
TOYOTA
3.9%
HYUNDAI
2.8%
RIVIAN
2.7%
VOLKSWAGEN
2.6%
JEEP
2.4%
VOLVO

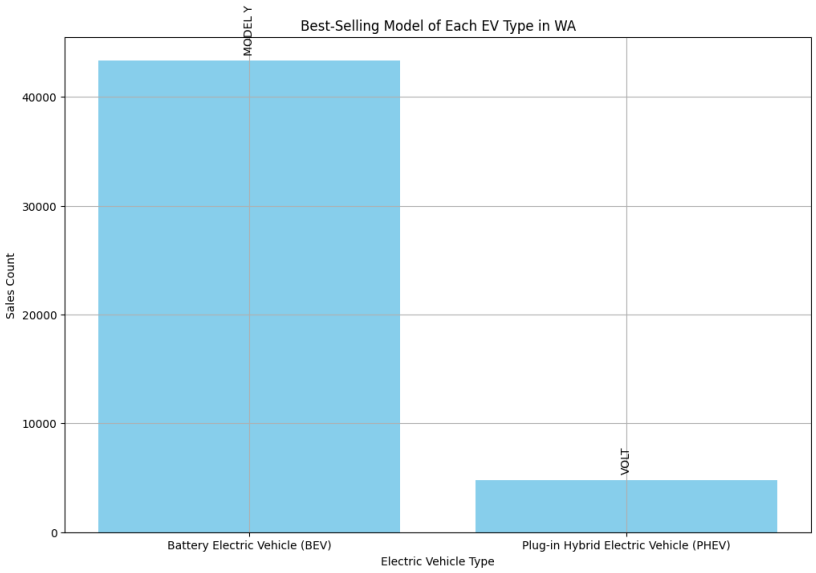

Number of Electric Utilities by Type
Number of Utilities
Electric Utility

2.

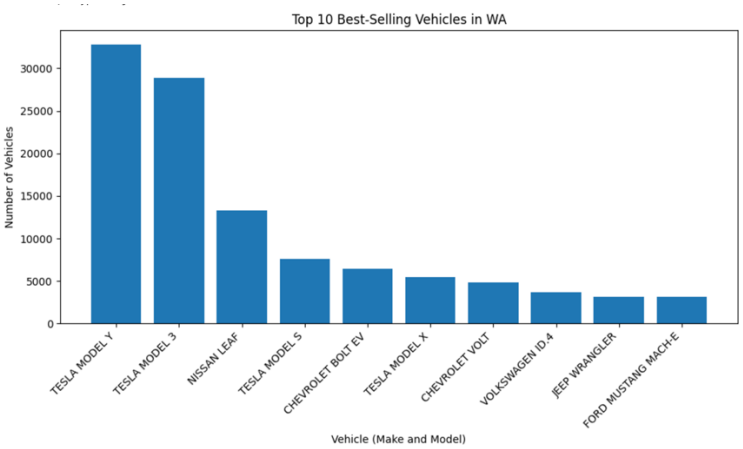

Best-Selling Models of Each Brand in WA
Sales Count
Brand
0
10000
20000
30000
40000
TESLA
NISSAN
CHEVROLET
VOLKSWAGEN
FORD
JEEP
CHRYSLER
KIA
HYUNDAI
TOYOTA
RIVIAN
BMW
VOLVO
SUBARU
POLESTAR
AUDI
MITSUBISHI
HONDA
MINI
FIAT
PORSCHE
MAZDA
DODGE
CADILLAC
MERCEDES-BENZ
LEXUS
LUCID
JAGUAR
LINCOLN
GENESIS
FISKER
SMART
ALFA ROMEO
LAND ROVER
GMC
ACURA
THINK
AZURE DYNAMICS
BENTLEY
WHEEGO ELECTRIC CARS
ROLLS-ROYCE
RAM
MODEL Y
LEAF
BOLT EV
ID.4
MUSTANG MACH-E
WRANGLER
PACIFICA
NIRO
IONIQ 5
RAV4 PRIME
R1S
X5
XC90
SOLTERRA
PS2
E-TRON
OUTLANDER
CLARITY
HARDTOP
500
TAYCAN
CX-90
HORNET
LYRIQ
EQB-CLASS
RZ
AIR
I-PACE
AVIATOR
GV60
OCEAN
FORTWO ELECTRIC DRIVE
TONALE
RANGE ROVER SPORT
HUMMER EV PICKUP
ZDX
CITY
TRANSIT CONNECT ELECTRIC
BENTAYGA
WHEEGO
SPECTRE
PROMASTER 3500

3.

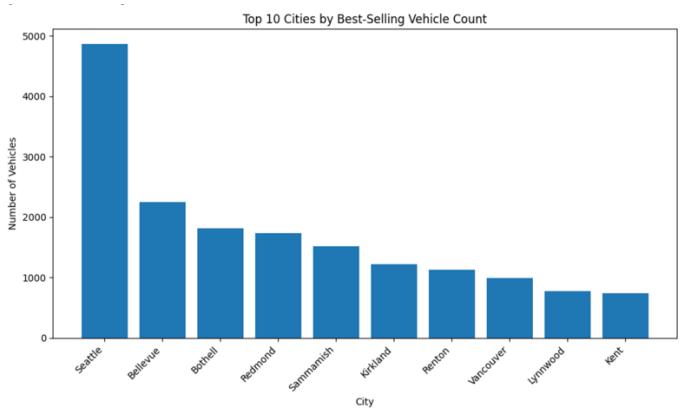

Best-Selling Brand of Each EV Type in WA
Sales Count
Electric Vehicle Type
0
20000
40000
60000
80000
TESLA
TOYOTA
Battery Electric Vehicle (BEV)
Plug-in Hybrid Electric Vehicle (PHEV)


Best-Selling Model of Each EV Type in WA
MODEL Y
VOLT
Sales Count
0
10000
20000
30000
40000
Battery Electric Vehicle (BEV)
Plug-in Hybrid Electric Vehicle (PHEV)
Electric Vehicle Type

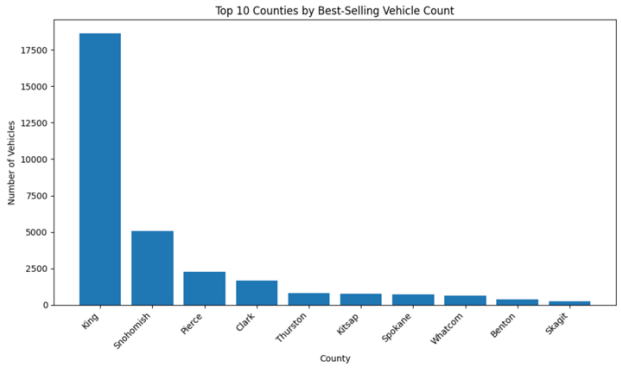
4.


Top 10 Best-Selling Vehicles in WA
Number of Vehicles
0
5000
10000
15000
20000
25000
30000
TESLA MODEL Y
TESLA MODEL 3
NISSAN LEAF
TESLA MODEL S
CHEVROLET BOLT EV
TESLA MODEL X
CHEVROLET VOLT
VOLKSWAGEN ID.4
JEEP WRANGLER
FORD MUSTANG MACH-E
Vehicle (Make and Model)

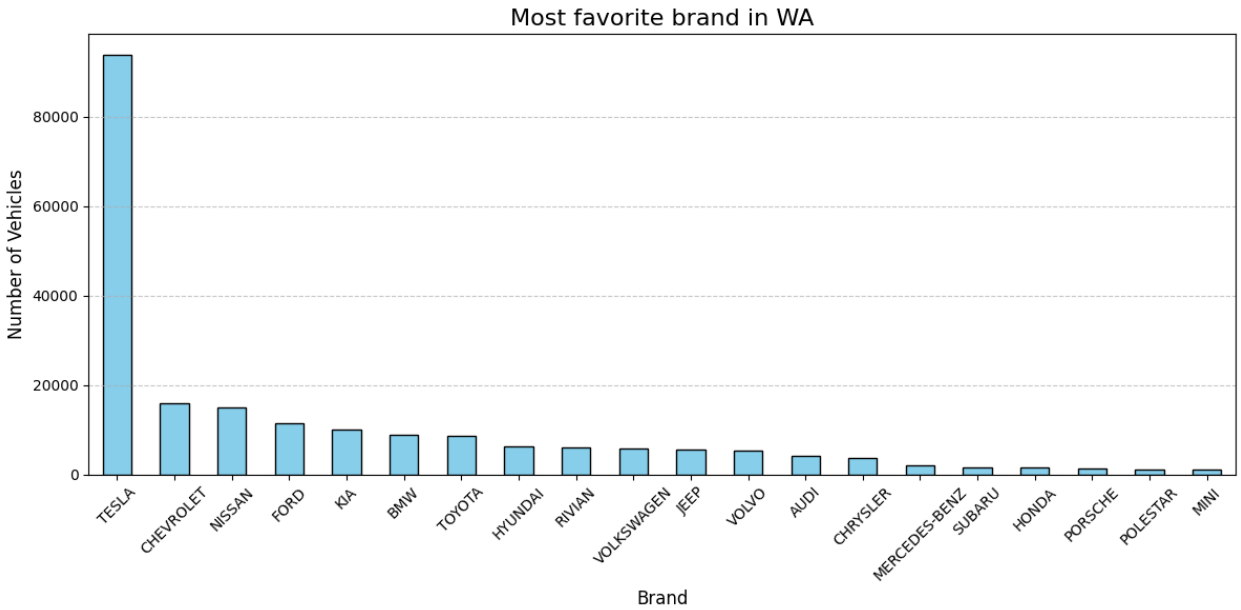
5.


Top 10 Cities by Best-Selling Vehicle Count
Number of Vehicles
0
1000
2000
3000
4000
5000
Seattle
Bellevue
Bothell
Redmond
Sammamish
Kirkland
Renton
Vancouver
Lynnwood
Kent
City

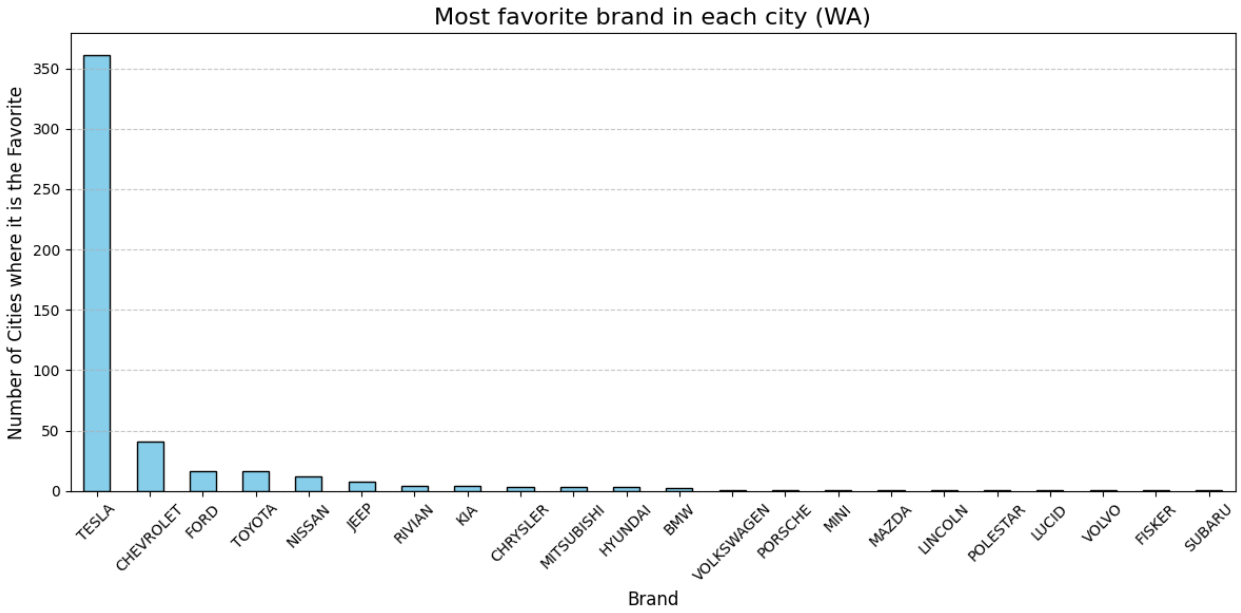
6.


Top 10 Counties by Best-Selling Vehicle Count
Number of Vehicles
17500
15000
12500
10000
7500
5000
2500
0
King
Snohomish
Pierce
Clark
Thurston
Kitsap
Spokane
Whatcom
Benton
Skagit
County

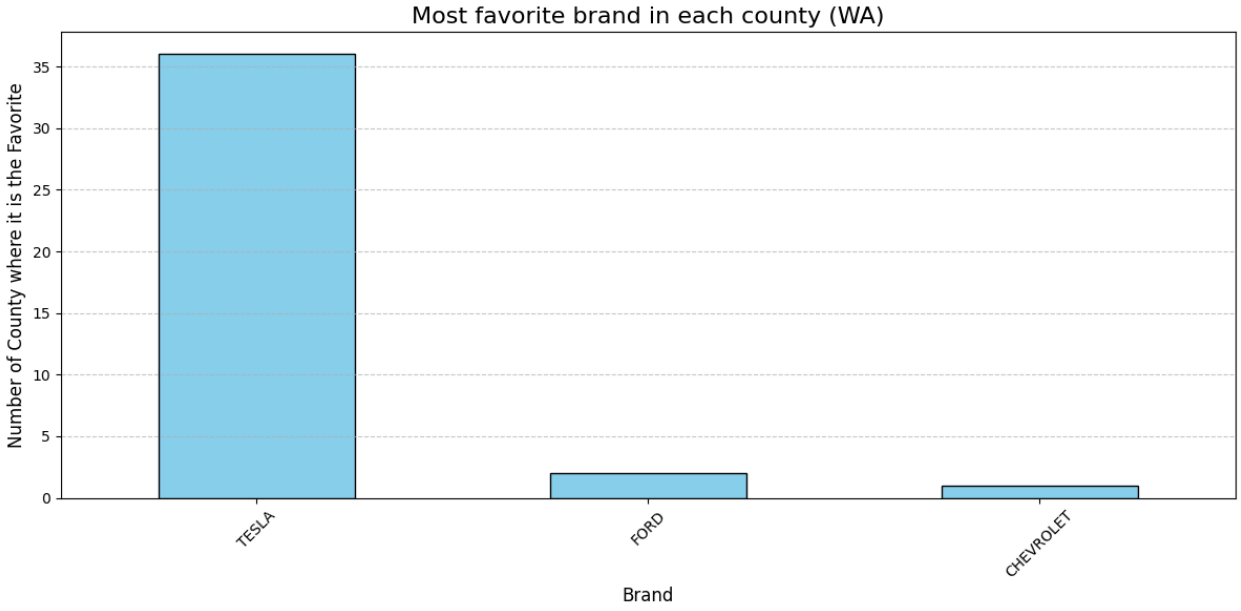
7.


Most favorite brand in WA
Number of Vehicles
80000
60000
40000
20000
0
TESLA
CHEVROLET
NISSAN
FORD
KIA
BMW
TOYOTA
HYUNDAI
RIVIAN
VOLKSWAGEN
JEEP
VOLVO
AUDI
CHRYSLER
MERCEDES-BENZ
SUBARU
HONDA
PORSCHE
POLESTAR
MINI
Brand

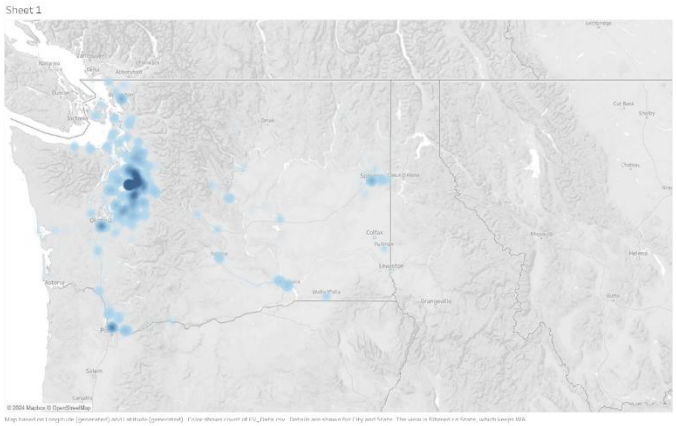
8.

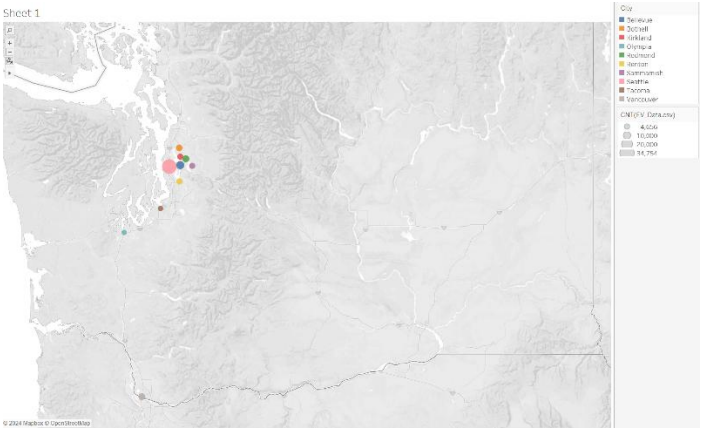

Most favorite brand in each city (WA)
Number of Cities where it is the Favorite
0
50
100
150
200
250
300
350
TESLA
CHEVROLET
FORD
TOYOTA
NISSAN
JEEP
RIVIAN
KIA
CHRYSLER
MITSUBISHI
HYUNDAI
BMW
VOLKSWAGEN
PORSCHE
MINI
MAZDA
LINCOLN
POLESTAR
LUCID
VOLVO
FISKER
SUBARU
Brand

9.

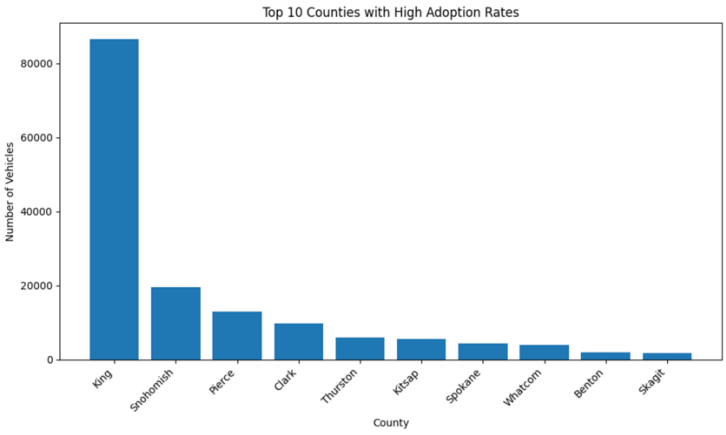

Most favorite brand in each county (WA)
Number of County where it is the Favorite
0
5
10
15
20
25
30
35
TESLA
FORD
CHEVROLET
Brand

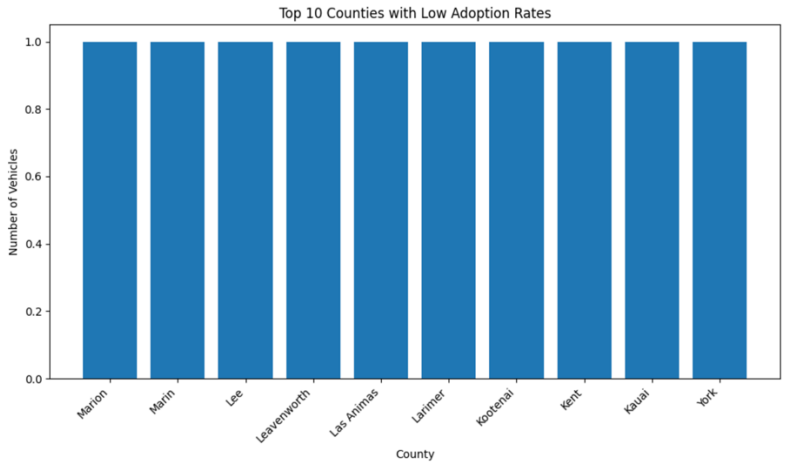
10.

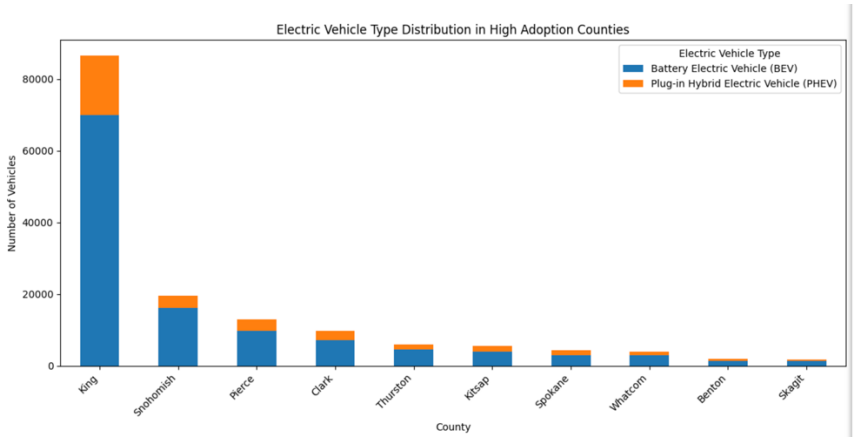

Sheet 1

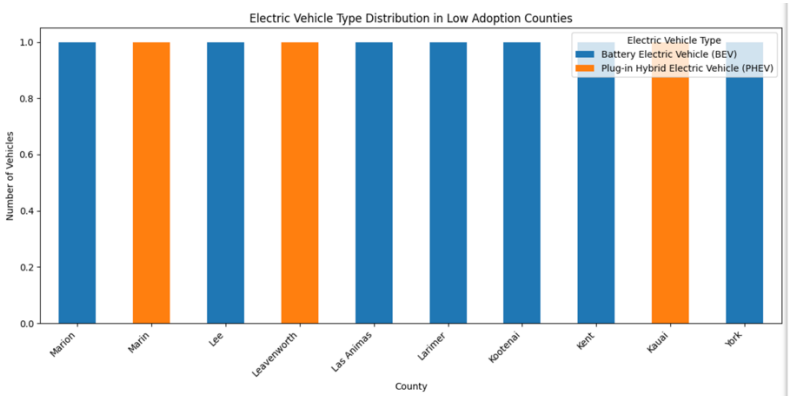

Sheet 1
City
Bellevue
Bothell
Kirkland
Olympia
Redmond
Renton
Sammamish
Seattle
Tacoma
Vancouver
CNT(EV Data.csv)
4,004
10,000
20,000
34,754

11.

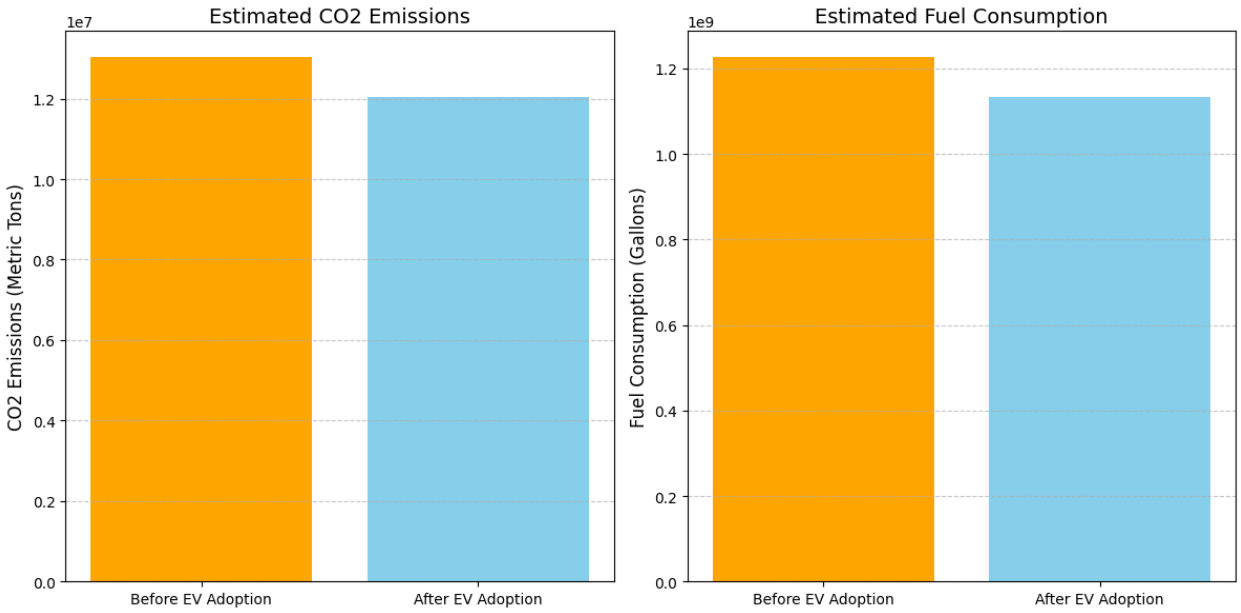

Top 10 Counties with High Adoption Rates
Number of Vehicles
0
20000
40000
60000
80000
King
Snohomish
Pierce
Clark
Thurston
Kitsap
Spokane
Whatcom
Benton
Skagit
County


Top 10 Counties with Low Adoption Rates
Number of Vehicles
1.0
0.8
0.6
0.4
0.2
0.0
Marion
Marin
Lee
Leavenworth
Las Animas
Larimer
Kootenai
Kent
Kauai
York
County


Electric Vehicle Type Distribution in High Adoption Counties
Electric Vehicle Type
Battery Electric Vehicle (BEV)
Plug-in Hybrid Electric Vehicle (PHEV)
Number of Vehicles
80000
60000
40000
20000
0
King
Snohomish
Pierce
Clark
Thurston
Kitsap
Spokane
Whatcom
Benton
Skagit
County


Electric Vehicle Type Distribution in Low Adoption Counties
Electric Vehicle Type
Battery Electric Vehicle (BEV)
Plug-in Hybrid Electric Vehicle (PHEV)
Number of Vehicles
1.0
0.8
0.6
0.4
0.2
0.0
Marion
Marin
Lee
Leavenworth
Las Animas
Larimer
Kootenai
Kent
Kauai
York
County

12.



Dataset

The dataset is chosen from DATA.GOV.

Link to Dataset: Electric Vehicle Population Data - Catalog

Dataset File Size: 49,110kb (CSV)

Number of Records: 205440

Result

https://github.com/Shadows2049/EV-Data-Analysis

Reference

[1] IEA (2024), Global EV Outlook 2024, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2024, Licence: CC BY 4.0

[2] Hannah Ritchie (2024) - “Tracking global data on electric vehicles” Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/electric-car-sales' [Online Resource]

[3] Statista - "Total number of registered automobiles in the US by state". Retrieved from: https://www.statista.com/statistics/196010/total-number-of-registered-automobiles-in-the-us-by-state/

[4] EPA - "Greenhouse gas emissions from a typical passenger vehicle". Retrieved from: https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#:~:text=typical%20passenger%20vehicle%3F-,A%20typical%20passenger%20vehicle%20emits%20about%204.6%20metric%20tons%20of,8%2C887%20grams%20of%20CO2.#

[5] Alternative Fuels Data Center - "Average fuel economy of vehicles". Retrieved from: https://afdc.energy.gov/data/10308