

# Business Analytics Case Study

*- Analyzing Electric Vehicle Market Dynamics in Washington -*



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## **Industry Experience**

*F&B, Sustainability & Energy, e-Commerce,  
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## **About me**

*Data-driven problem solver with  
experience in business analytics,  
turning data into actionable insights to  
support strategic decisions. Skilled in  
applying R, SQL, Power BI and data  
visualization tools*

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# Data Analysis Case Study

## Analyzing Electric Vehicle Market Dynamics in Washington

### Purpose of the Project

Exploring the dynamics of the electric vehicle market in Washington State, focusing on data-driven insights to understand adoption patterns and influencing factors

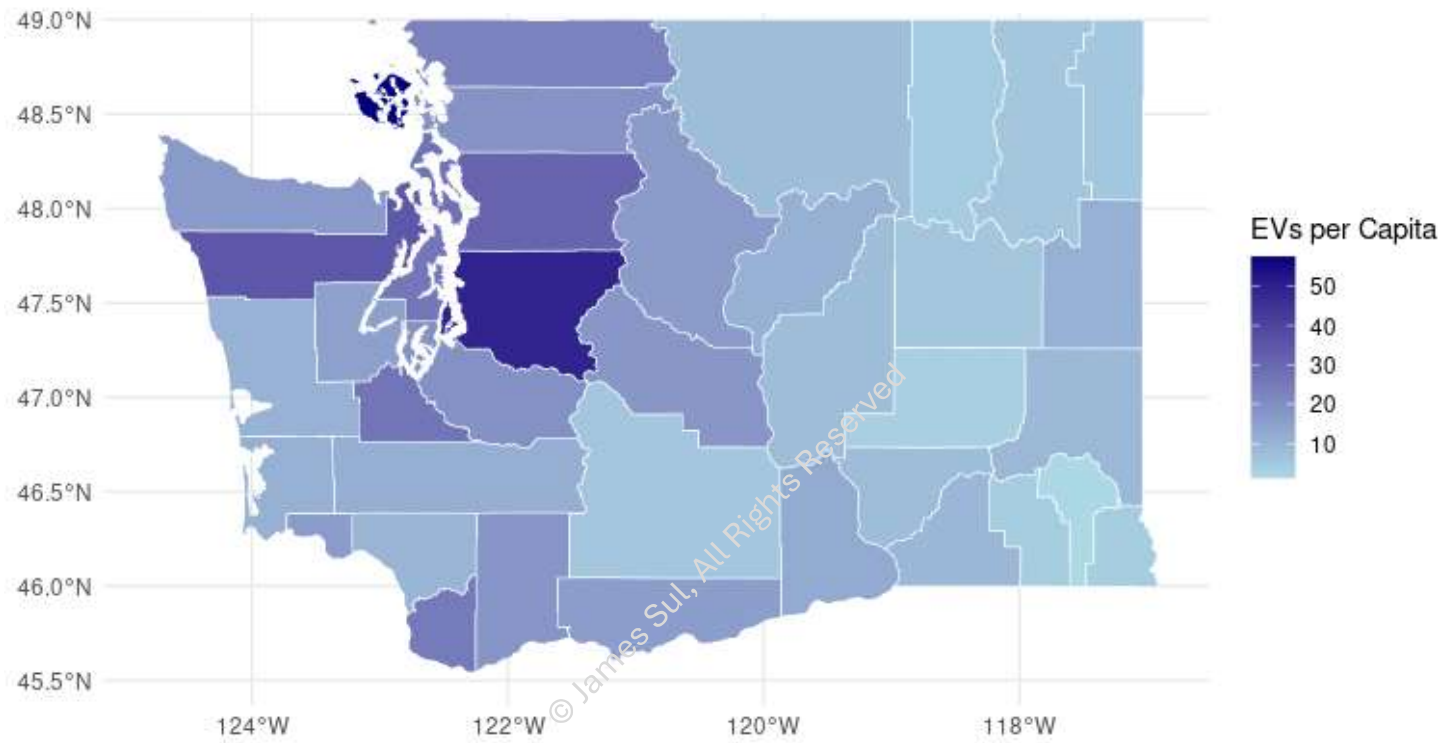
### Data Analysis Process

- *Data Collection (Electric Vehicle Population and Demographic Data in WA)*
- *Data Cleaning & Preparation (Cleaning, Formatting, and Feature Engineering)*
- *Exploratory Data Analysis (Detection and Correction of Outliers)*
- *Modeling and Analysis (Regression Analysis and Time Series Visualization)*
- *Insights and Interpretation*
- *Summary and Visualization*

**Data Analysis Tool Used :** R, Excel, and ChatGPT

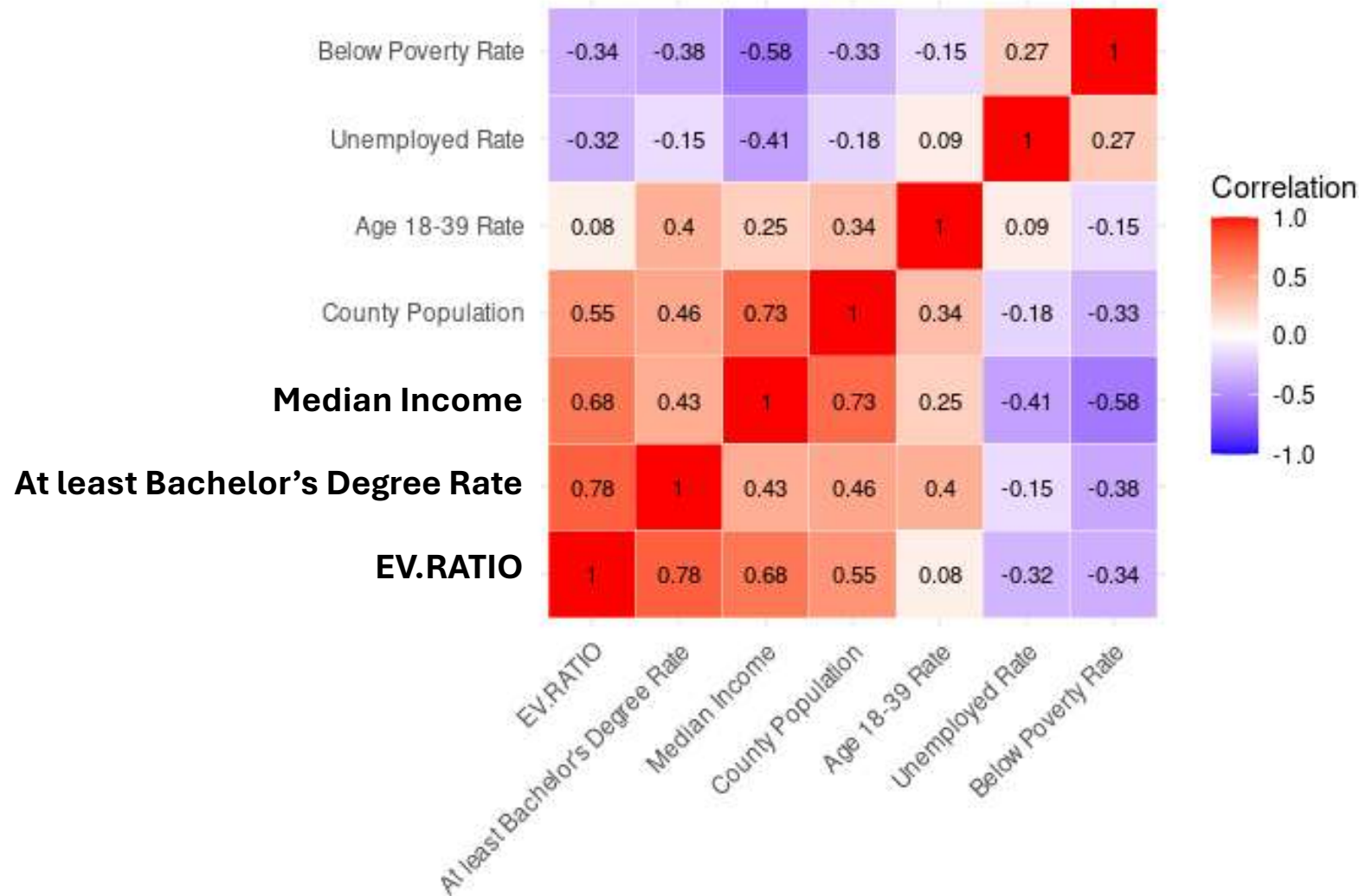
## Electric Vehicles per Capita in WA

Ratio of EV Count to Population by County



- ☒ Electric Vehicles per Capita (EV.RATIO) represents the ratio of electric vehicles to the population for each county
- ☒ King County, home to major tech companies like Microsoft and Amazon, demonstrates the highest EV adoption rate in Washington State
- ☒ *What factors contribute to this high adoption rate?*

## Correlation Heat Map by EV.RATIO



- ☒ To identify correlated factors, demographic data was merged, and a heatmap was created for visual analysis
- ☒ The heatmap indicates that the **'At least Bachelor's Degree Rate'** has the highest correlation with **'EV.RATIO'**, followed by **'Median Income'**

## Regression Model

Call:

```
lm(formula = EV.RATIO ~ `Median Income` + `County Population` +
  `Age 18-39 Rate` + `At least Bachelor's Degree Rate` + `Unemployed Rate` +
  `Below Poverty Rate`, data = regression_data)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.0091471	-0.0016700	0.0000589	0.0022811	0.0078930

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-3.700e-02	9.498e-03	-3.896	0.000508	***
`Median Income`	4.240e-07	8.193e-08	5.175	1.42e-05	***
`County Population`	-1.838e-09	2.462e-09	-0.747	0.461094	
`Age 18-39 Rate`	-4.442e-04	1.037e-04	-4.283	0.000175	***
`At least Bachelor's Degree Rate`	7.519e-04	7.929e-05	9.483	1.55e-10	***
`Unemployed Rate`	4.871e-05	6.197e-04	0.079	0.937873	
`Below Poverty Rate`	1.093e-03	3.877e-04	2.818	0.008476	**
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Residual standard error: 0.003808 on 30 degrees of freedom

Multiple R-squared: 0.871, Adjusted R-squared: 0.8452

F-statistic: 33.75 on 6 and 30 DF, p-value: 4.81e-12

- ☑ When running the regression with variables from the heatmap, the two most significant predictors, '**At least Bachelor's Degree Rate**' and '**Median Income**', show strong statistical significance with p-values below 0.05.
- ☑ On the other hands '**County Population**' and '**Unemployed Rate**' shows no statistically significant impact on EV adoption, with p-values above 0.05 suggesting they are less relevant predictors in this model



## Regression Model

```
Call:
lm(formula = EV.RATIO ~ `Median Income` + `Age 18-39 Rate` +
    `At least Bachelor's Degree Rate` + `Below Poverty Rate`,
    data = regression_data)

Residuals:
    Min       1Q   Median       3Q      Max
-0.0086540 -0.0016954 -0.0001837  0.0023606  0.0085729

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)   -3.300e-02  6.247e-03  -5.282 8.75e-06 ***
`Median Income`  3.833e-07  5.514e-08   6.952 7.11e-08 ***
`Age 18-39 Rate` -4.553e-04  9.815e-05  -4.639 5.65e-05 ***
`At least Bachelor's Degree Rate` 7.393e-04  7.561e-05   9.778 3.92e-11 ***
`Below Poverty Rate` 1.028e-03  3.692e-04   2.783 0.00895 **
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

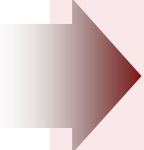
Residual standard error: 0.003721 on 32 degrees of freedom
Multiple R-squared: 0.8686, Adjusted R-squared: 0.8521
F-statistic: 52.86 on 4 and 32 DF, p-value: 1.182e-13
```

- ☑ After removing two irrelevant variables, the regression model achieved an **R-squared of 0.8686**
- ☑ To address potential overfitting, I checked for multicollinearity using the Variance Inflation Factor (VIF). All variables showed acceptable VIF values ranging between 1.2 and 1.65, indicating no significant multicollinearity issues

## Key Insights on Market Analysis

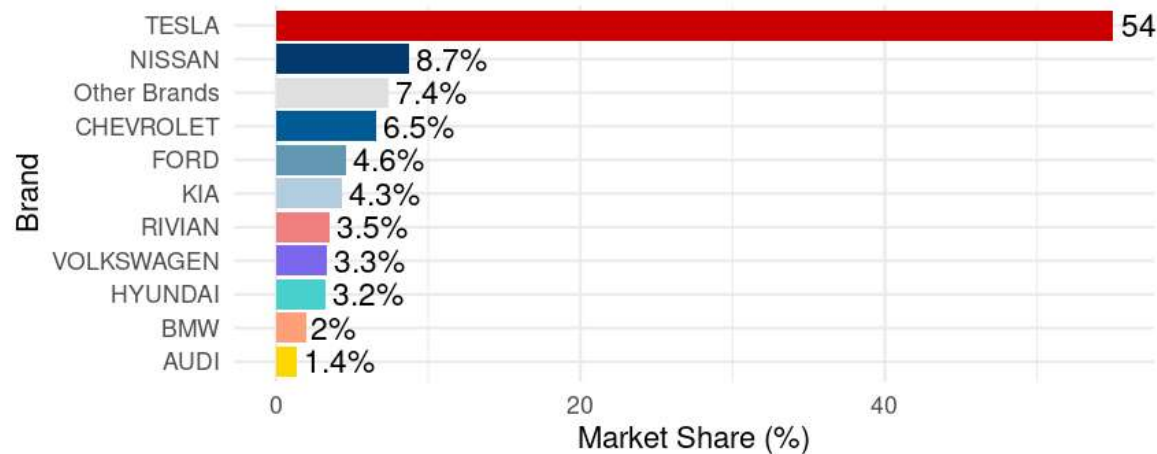
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The analysis reveals that demographic factors such as income, education, and age play a significant role in influencing EV adoption. With an R-squared value of 0.8686 and no multicollinearity issues, the model offers a reliable foundation for developing data-driven EV policies and targeted marketing strategies.



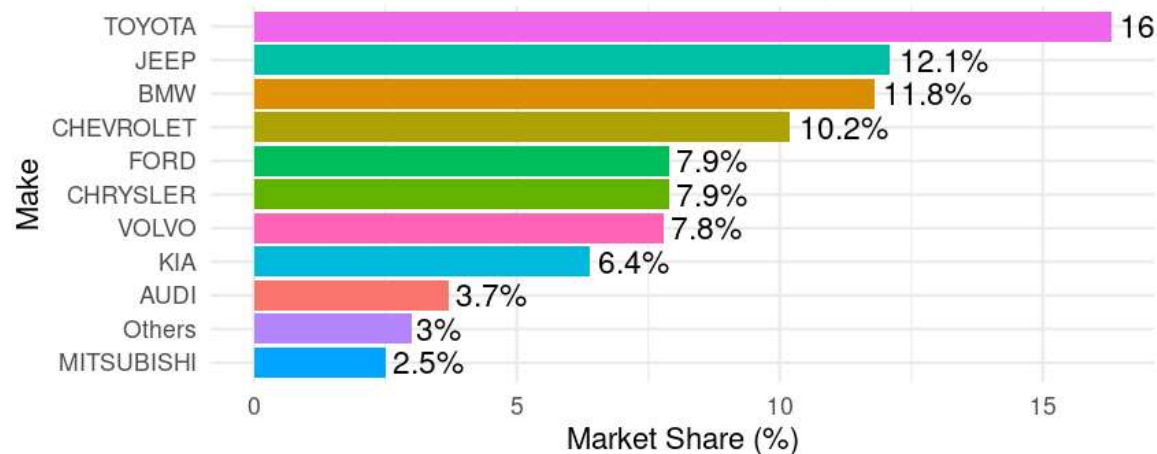
***The next step was to dive into the data to uncover key market trends and drivers, starting with brand performance across BEV and PHEV categories***

## BEV Market Share by Brand



- For the BEV market in WA, Tesla dominates with 54% of the total market share, highlighting a significant lead over its competitors

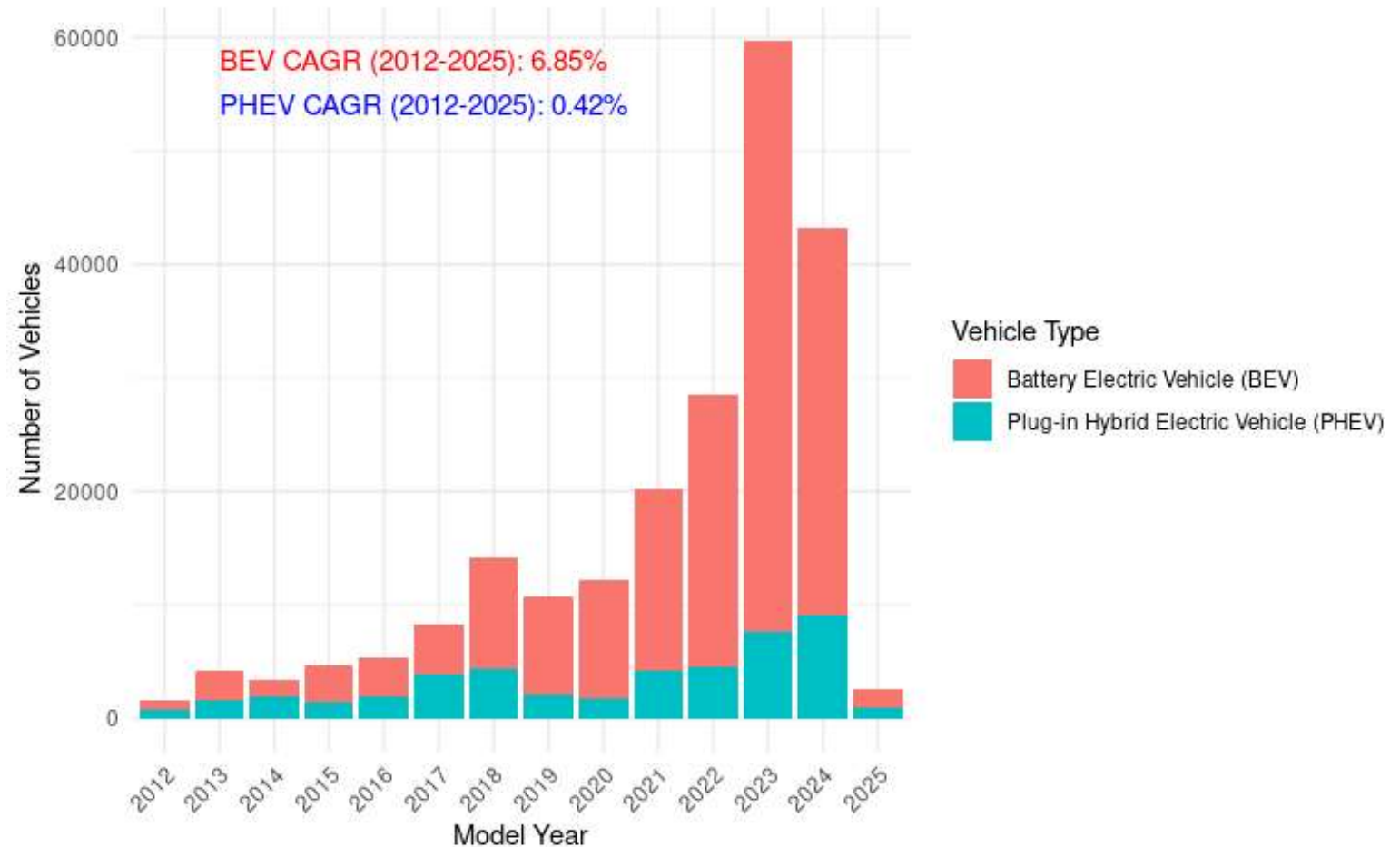
## PHEV Market Share by Brand



- For the PHEV market, Toyota leads; however, the gap between competitors is much smaller compared to the BEV market, indicating a more evenly distributed market share.



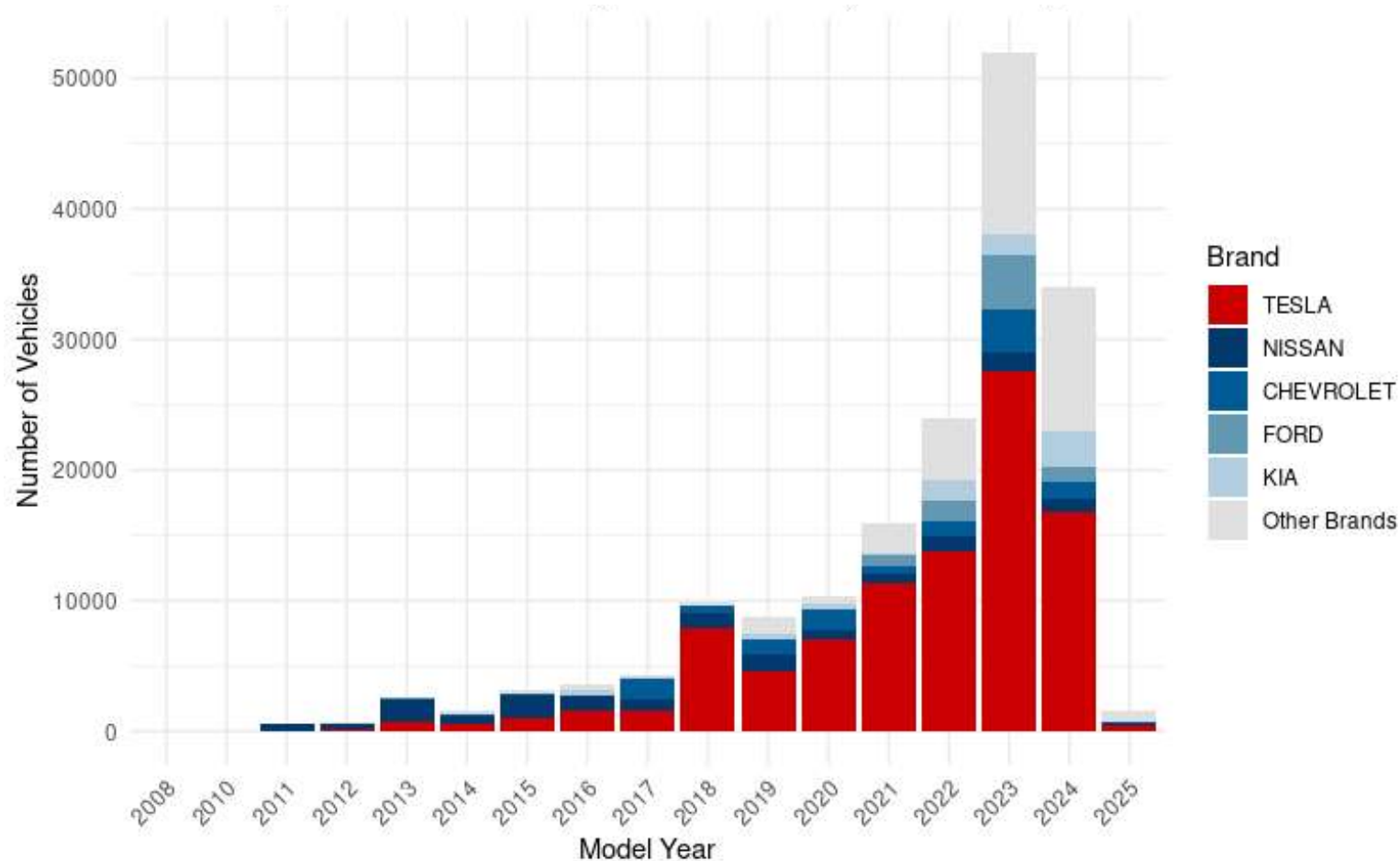
## BEV vs PHEV Market Share (2012-2025)



- ✓ When incorporating a time series by model year, Battery Electric Vehicles (BEVs) have driven EV growth in Washington with a CAGR of 6.58%, while Plug-in Hybrid Electric Vehicles (PHEVs) show a modest CAGR of 0.42%

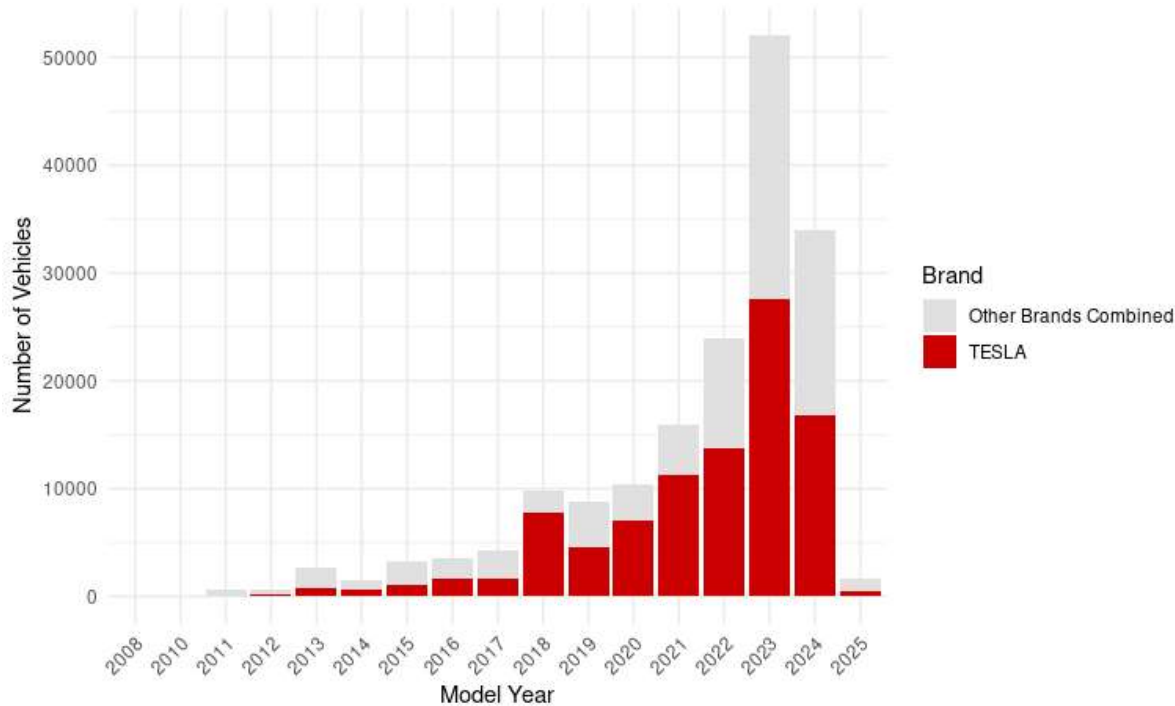
- ✓ *What factors have driven this increase in BEV?*

## Top 5 BEV Brands by Model Year (2012-2025)

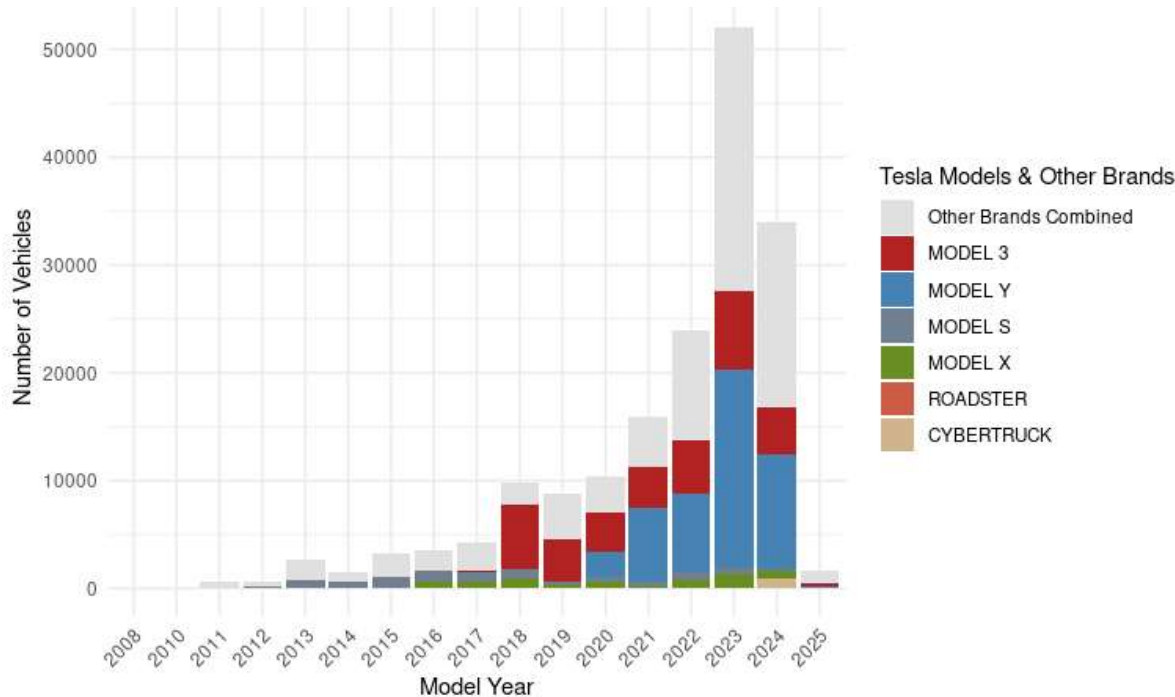


- ☑ To identify key drivers, I divided the bar graph by brand to highlight the contribution of each BEV brand among the 37 brands in total
- ☑ The graph highlights that Tesla has contributed the most significantly to the upward trend, clearly dominating the BEV market share

## BEV Brand Comparison by Model Year



## BEV Comparison by Model and Year



✓ What factors influenced this explosive growth for the model years 2022 and 2023?

✓ Focusing on Tesla, the breakdown by model shows that the Model Y significantly contributed to the sharp increase in 2023, playing a pivotal role in the explosive growth observed

✓ I hypothesize that the growth may have been driven by:

1) Product Upgrades: Introduction of a refreshed version or new features for the Model Y, enhancing its value proposition

2) Price Incentives: Strategic pricing adjustments and policy-driven subsidies, such as tax credits and rebates, likely reduced the effective purchase price and boosted demand

## Hypothesis 1: Product Upgrades

Mar 2023

Mar 2025



Model Y

Starting Price After Est. Savings:  
\$31,490<sup>1</sup>

Available Now



New Model Y

Starting Price After Est. Savings:  
\$46,490<sup>1</sup>

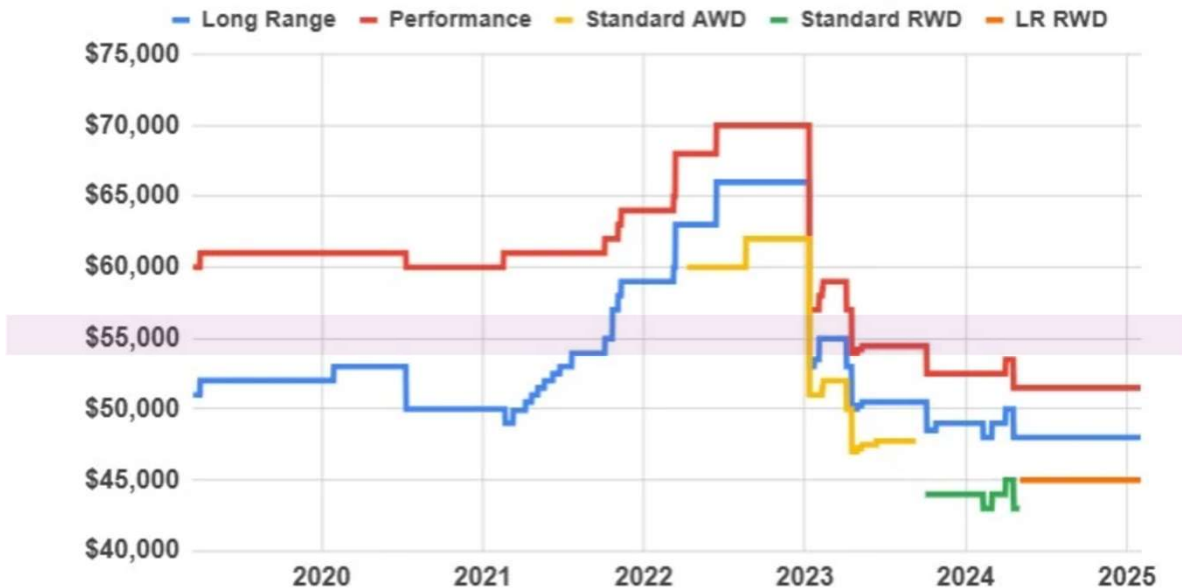
Available Starting March

*\* Image Source: Tesla. (2025). Model Y Overview. Retrieved from <https://www.tesla.com/modely>*

- ☒ Research indicates that while Tesla Model Y underwent interior refreshes and Vision & Safety upgrades, these changes were incremental rather than groundbreaking. Therefore, they are unlikely to account for the explosive growth observed during the analyzed period
- ☒ Furthermore, the significantly upgraded new Model Y only began deliveries in March this year, outside the scope of this analysis. Thus, **Hypothesis 1 is rejected** as the primary explanation for the sharp increase in sales

## Hypothesis2: Price Incentives

### Tesla Model Y Price History



### EV Tax Incentives Overview in WA

Row	2012_2018	2019	2020	2021	2022	2023	2024
Up to Sales Tax Exemption	\$32,000	\$25,000	\$20,000	\$15,000	\$15,000	\$20,000	\$20,000
Up to Eligible Vehicle Price	\$42,500	\$45,000	\$45,000	\$45,000	\$45,000	\$55,000	\$55,000
Tax Savings (6.5%)	\$ 2,080	\$ 1,625	\$ 1,300	\$ 975	\$ 975	\$ 1,300	\$ 1,300
Tax Savings (9.5%)	\$ 3,040	\$ 2,375	\$ 1,900	\$ 1,425	\$ 1,425	\$ 1,900	\$ 1,900

- ✓ In 2023, Tesla's pricing strategy aligned with Washington State's expanded sales tax exemption policies
- ✓ The price of the Model Y Performance dropped below the newly raised eligibility limit of \$55,000, while the sales tax exemption increased from \$15,000 to \$20,000, providing buyers with significant additional savings
- ✓ These factors likely contributed to the observed surge in Model Y sales, **supporting Hypothesis 2**

## Key Insights on Policy and Pricing Impact

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The Tesla Model Y price reduction combined with Washington's expanded EV incentives substantially lowered the effective purchase price, significantly improving affordability and likely driving higher demand for the Model Y

### Overall Conclusion

- 1** The EV market in Washington is primarily driven by King County, which includes Seattle, home to major tech companies
- 2** Tech industry professionals in this region, with over 60% holding a bachelor's degree or higher and a median income exceeding \$90K, exhibit a strong correlation with higher EV adoption
- 3** Yearly EV adoption trends are led by Tesla, which holds over 54% of the BEV market share in Washington, playing a dominant role in shaping the market
- 4** Tesla's pricing strategy aligned with WA's flexible EV tax incentives. The 2023 sales tax exemption raised to \$55,000 influenced adoption dynamics and boosted demand



## \* Data Sources

- Data.gov – [Electric Vehicle Population Data](#)
- National Institute on Minority Health and Health Disparities Data Portal – [Link](#)
- Tesla (2025). *Model Y Overview*. Retrieved from <https://www.tesla.com/modely>
- Kehm, B. (2025). *Tesla Model Y Price History*. Retrieved from <https://briankehm.com/tesla-model-y-price-history/>