

Electric Vehicle Adoption in Washington State

Understanding Current Trends Through
Exploratory Data Analysis

ISE 201, Fall 2025



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Research Objectives

Project goal

Explore trends in vehicle types, electric range, pricing, and geographic adoption patterns

Research Questions

1. What is the distribution of battery electric vehicles (BEVs) vs. plug-in hybrid electric vehicles (PHEVs)?
2. Which counties and cities have the highest concentration of EVs?
3. Which manufacturers and models dominate the EV market?
4. How has adoption changed across model years?
5. How do electric range and base MSRP vary across manufacturers and models?

Data Overview

- Consists 264,628 records, and 17 variables
- 9 categorical and 2 numerical variables will be used

#	Variables	Type
1	VIN	Not used
2	County	Categorical
3	City	Categorical
4	State	Categorical
5	Postal Code	Not used
6	Model Year	Categorical

#	Variables	Type
7	Make	Categorical
8	Model	Categorical
9	EV Type	Categorical
10	CAFV Eligibility	Categorical
11	Electric Range	Numerical
12	Base MSRP	Numerical

#	Variables	Type
13	Legislative District	Not used
14	DOL Vehicle ID	Not used
15	Vehicle Location	Not used
16	Electric Utility	Categorical
17	2020 Census Tract	Not used

Data Overview / Key Data Quality Issues

1. Missing values

County	9
City	9
State	0
Model Year	0
Make	0
Model	0
Electric Vehicle Type	0
Clean Alternative Fuel Vehicle (CAFV) Eligibility	0
Electric Range	4
Base MSRP	4
Electric Utility	9

- **Categorical variables:**

9 records contain missing values in county, city, and electric utility → imputed as “Unknown”

- **Numerical variables:**

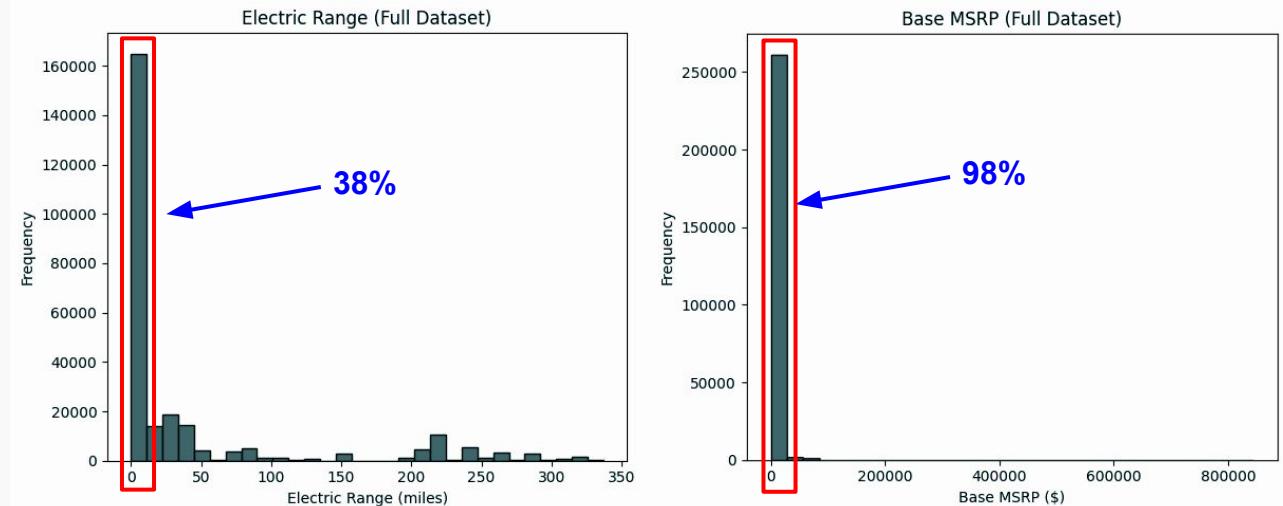
4 records contain missing values in electric range and base MSRP
→ imputes as **0**

Data Overview / Key Data Quality Issues

1. Missing values

2. Zero values

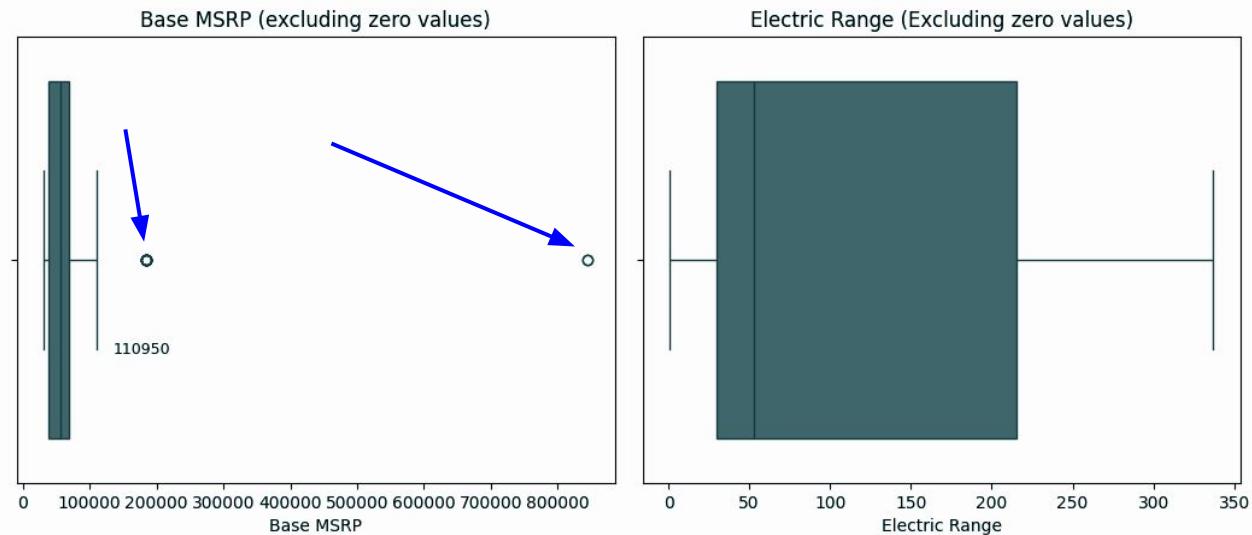
- **Electric range:** 100,827 records from BEVs
- **Base MSRP:** 260,000 records
- **Impact:** severe skewness masking non-zero distributions



Data Overview / Key Data Quality Issues

1. Missing values
2. Zero values
3. Outliers

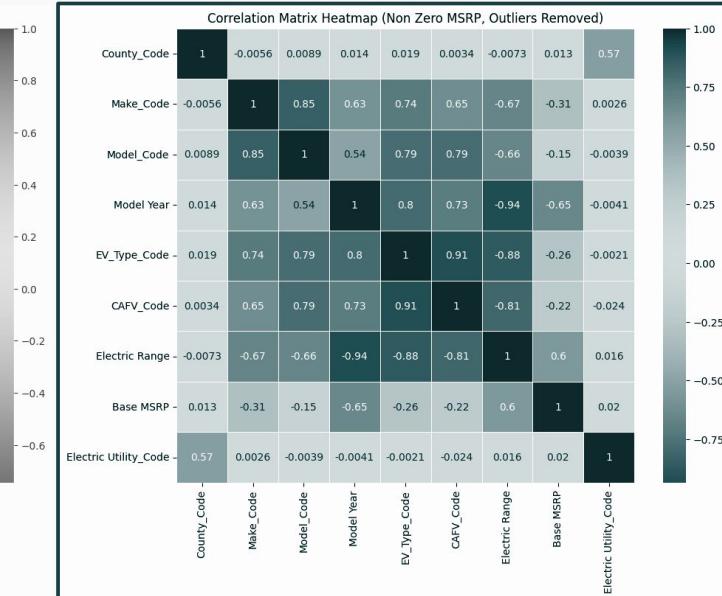
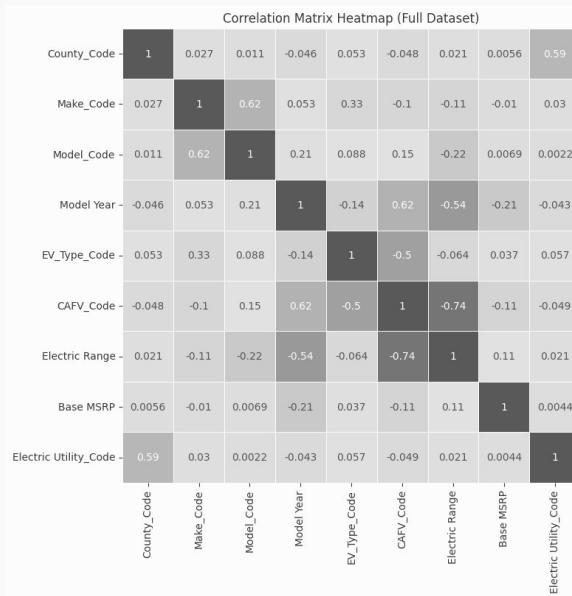
- Extreme high-price outliers (>\$150k) in Base MSRP (after removing zeros)
- No outliers in Electric Range



Data Preparation

1. Converted **Model Year** from numerical to categorical format
2. Created derived variables: **City_County** and **Model_Make**
3. Encoded categorical variables for correlation analysis, including:
 - EV type
 - CAFV eligibility
 - Make
 - Model
 - County
 - Electric utility

EDA: Correlation Matrix

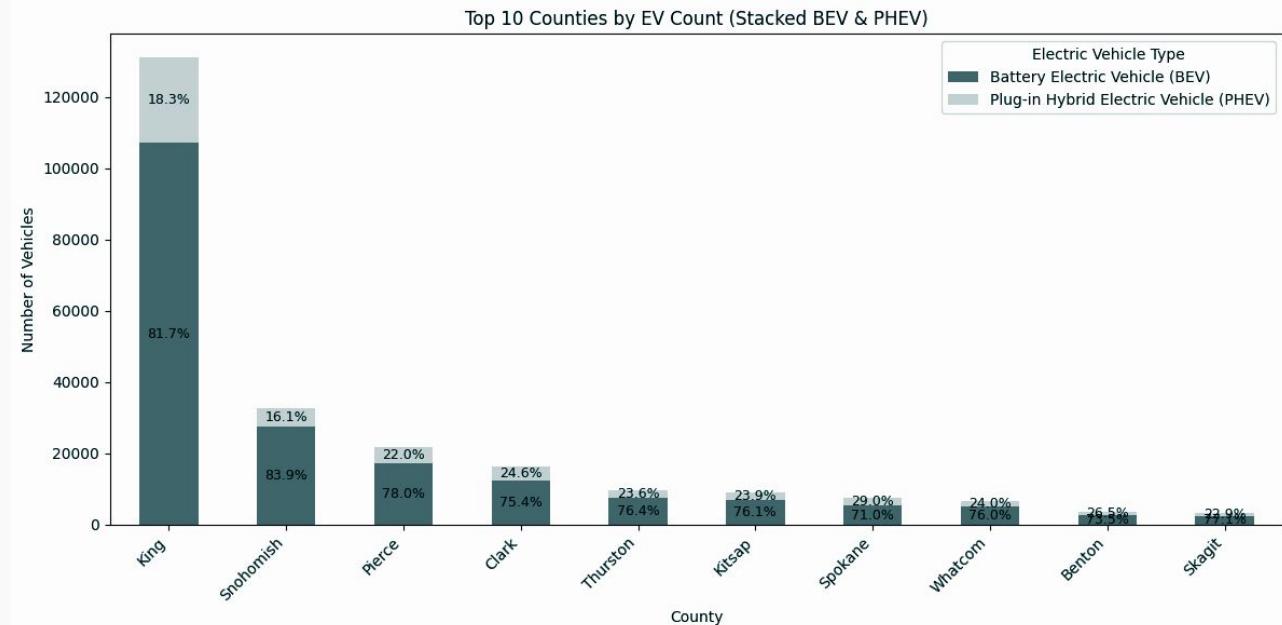
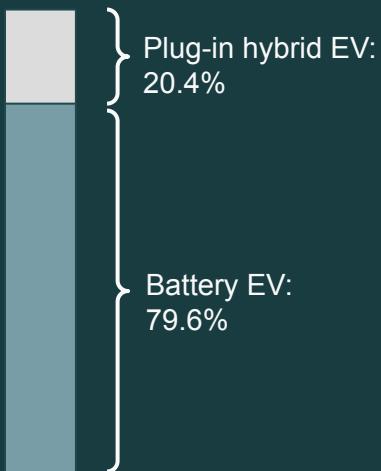


Strong relationships:

1. Make & Model
2. Model year & Electric Range
3. Model year & EV type
4. EV type & CAFV eligibility
5. EV type & Electric Range
6. CAFV eligibility & Electric Range

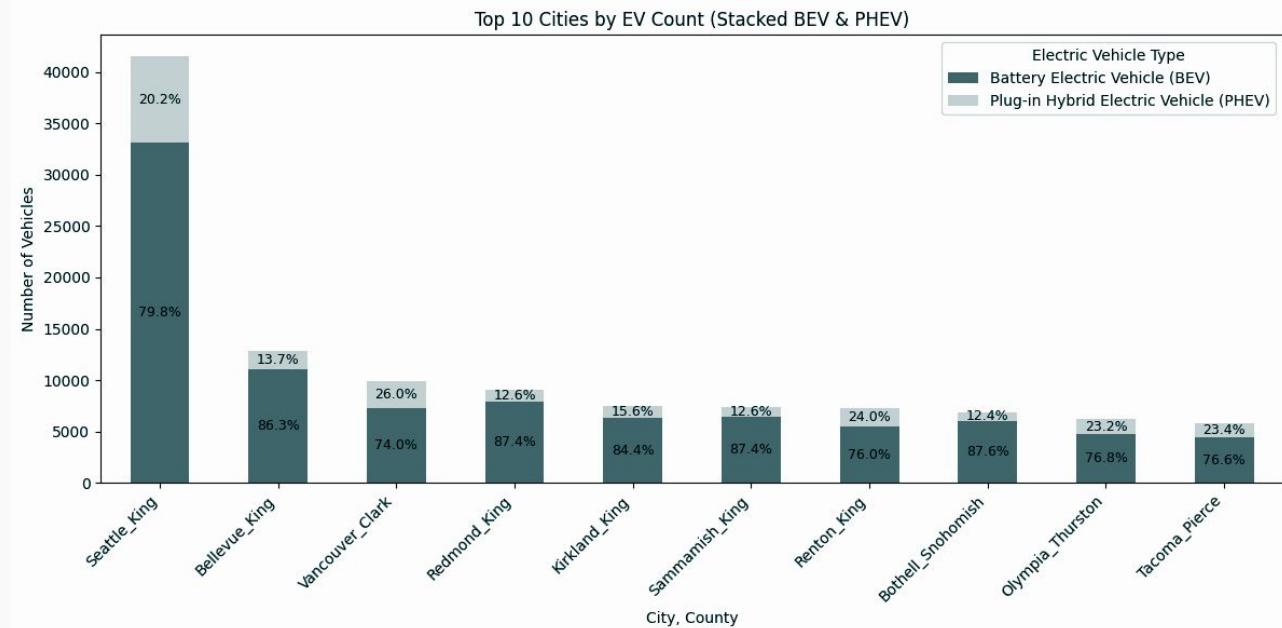
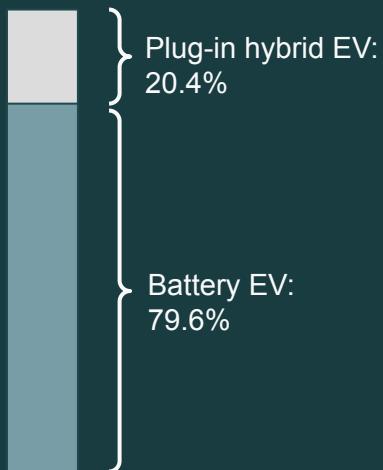
EDA: Relationships Between Variables

1. Electric vehicle (EV) type vs. location (county, city)



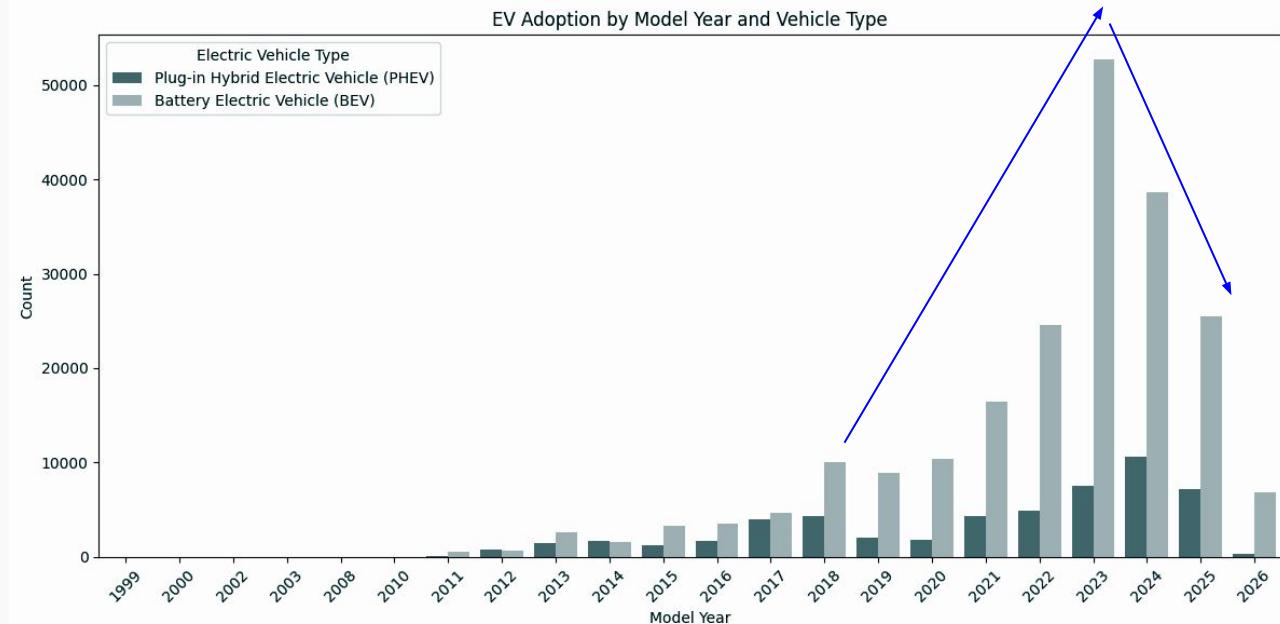
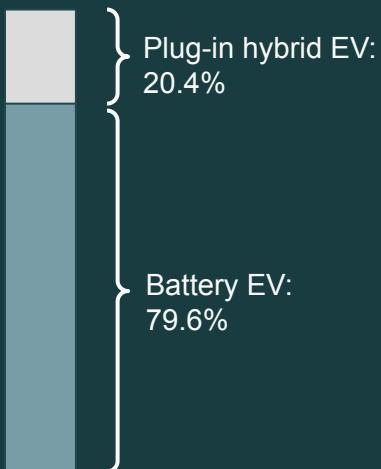
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EDA: Relationships Between Variables

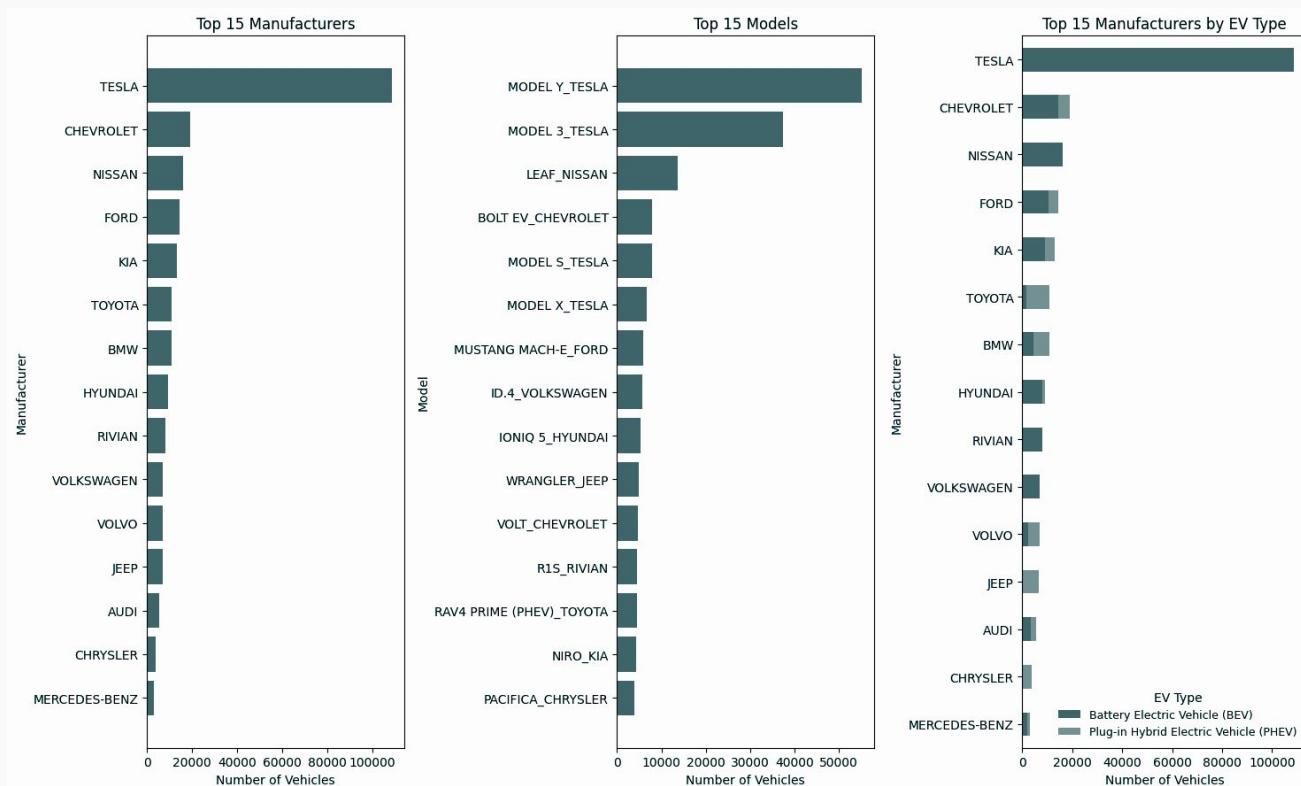
1. Electric vehicle (EV) type vs. model year



EDA: Relationships Between Variables

2. Make, Model vs. EV type

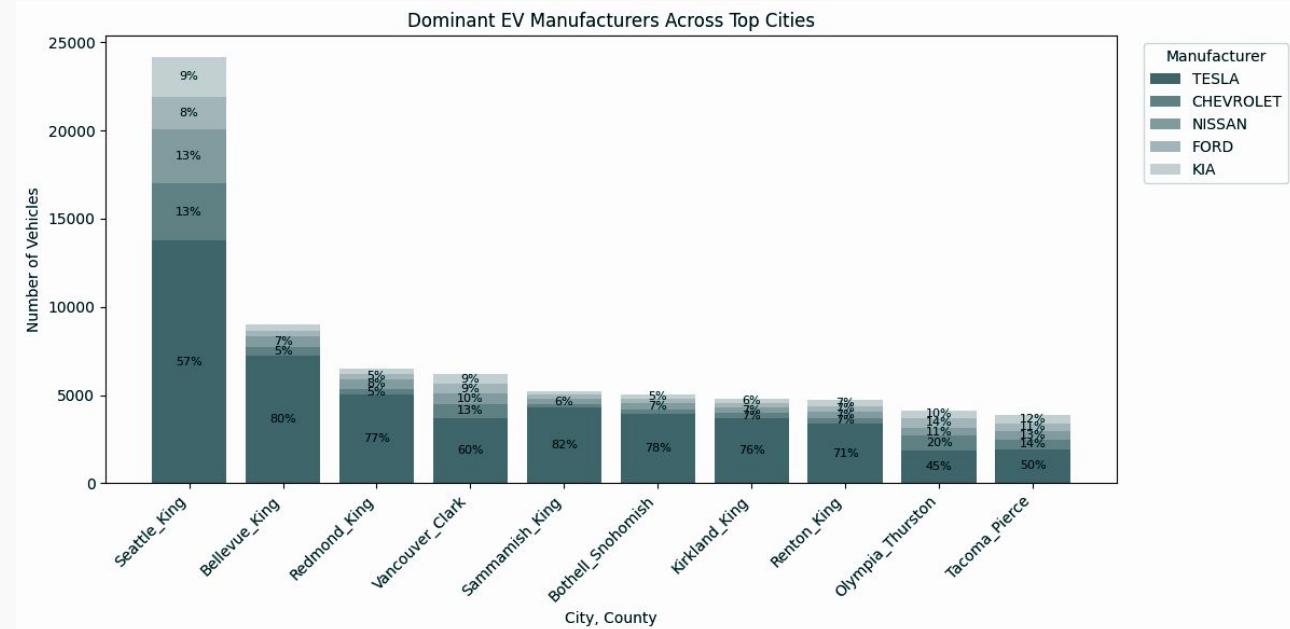
- Tesla is the dominant EV manufacturer in Washington State
- Model Y, Model 3 and Nissan Leaf are the top three registered models
- Tesla, Nissan, Rivian, and Volkswagen focus predominantly on BEVs



EDA: Relationships Between Variables

2. Make, Model vs. location

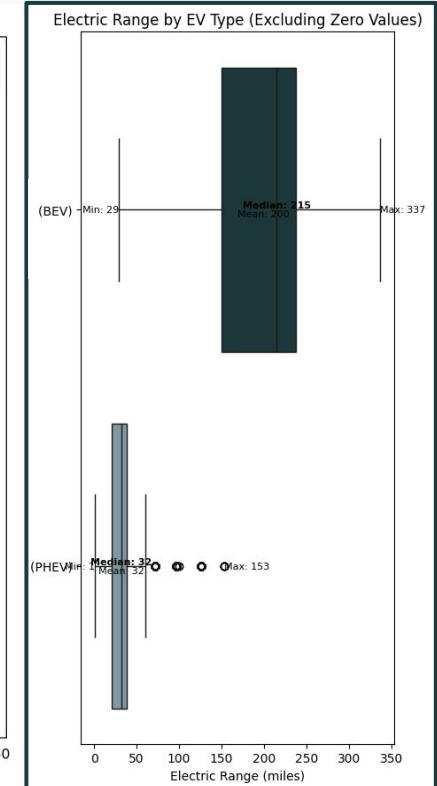
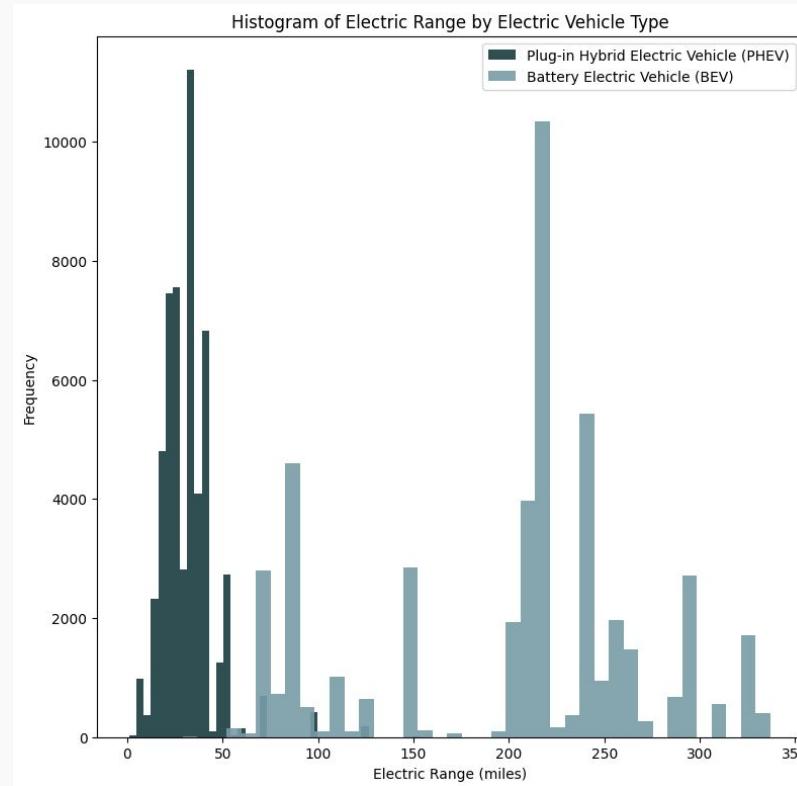
- Tesla remains the dominant manufacturer across cities; Chevrolet and Nissan follow at a distant second tier.



EDA: Relationships Between Variables

3. Electric Range vs. EV type

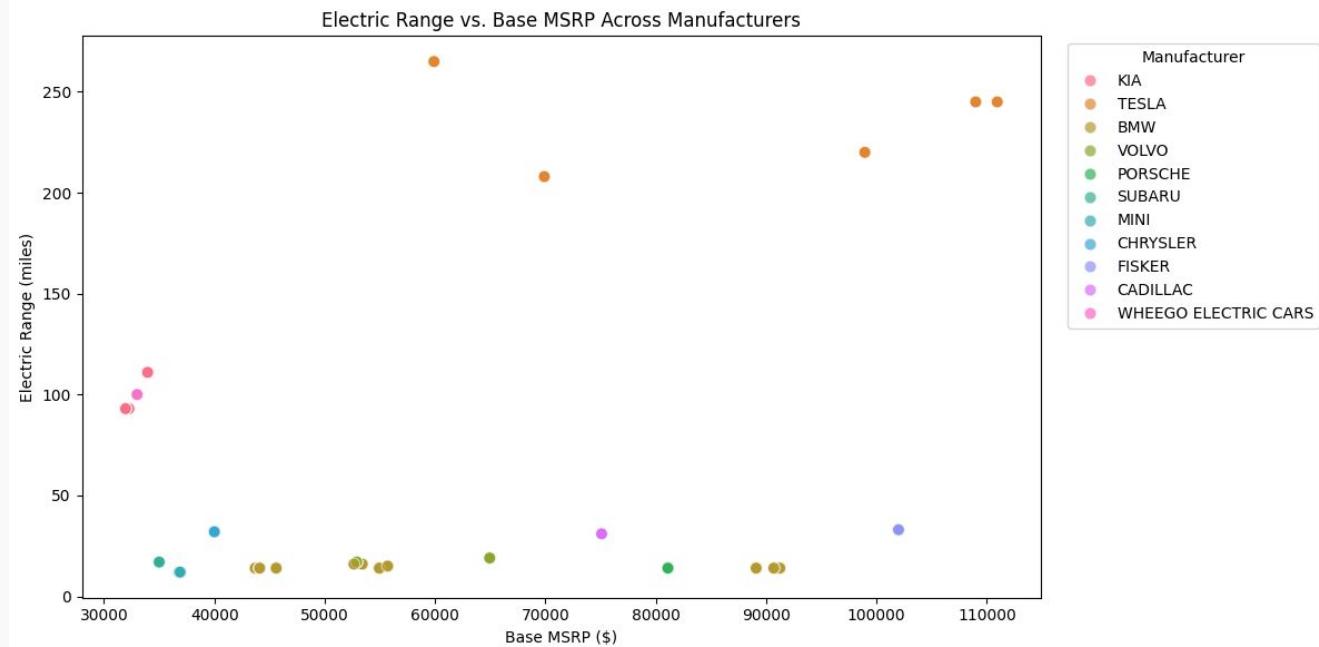
Stat	Full	Non zero	BEV	PHEV
min	0	1	29	1
max	337	337	337	153
mean	41.7	109.5	199.5	31.6
med	0	53	215	32
std	80.4	97.7	72.2	14.1



EDA: Relationships Between Variables

3. Electric Range vs. base MSRP

- Higher MSRP does not uniformly correspond to greater electric range.
- Clear manufacturer-level patterns emerge:
 - Premium brands offer higher-range vehicles at higher price points: Tesla, Volvo, and Porsche
 - Value brands concentrated in the lower-range, lower-price segment: Kia, MINI, and Chrysler



Key Findings

- Battery electric vehicles (BEVs) dominate EV adoption
- Tesla holds a dominant market share across the state
- EV adoption is concentrated in major cities and counties

Unexpected insights:

- EV adoption accelerates rapidly after 2018, followed by a noticeable decline after 2023
- Electric range and base MSRP show no strong positive relationship; instead, both are largely driven by manufacturer production strategies

What I learned from the EDA process:

- Visual inspection is essential for identifying data issues early
- Patterns should not be assumed until data quality issues are addressed
- Research questions evolve as deeper insights emerge
- Separating Tesla from non-Tesla vehicles reveals clearer market dynamics

Next Steps

The findings also raise new questions that extend beyond the original research scope:

- What **demographic or socioeconomic factors** explain why King County leads EV adoption so strongly?
- How does **charging infrastructure availability** influence adoption patterns across cities?
- Do **policy incentives (e.g., CAFV eligibility) meaningfully shift consumer behavior**, or do range and brand reputation dominate choices?



Thank you