Project Topic:

Electric Vehicle Market Dynamics in Washington State: A Comparative Study of Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV) by Range, Price, and Region.

Data Cleaning & Preprocessing

- Filled missing categorical values using mode, and numerical values using median.
- Filled missing values with median for numerical and mode for categorical.
- Dropped rows with missing critical data (e.g., `Legislative District`, vehicle location).
- Duplicates and incomplete rows removed.
- Converted data types to improve consistency and memory usage.
- Added new columns:

    - Vehicle_Age` = 2025 − Model Year

    - `Price_per_Mile` = Base MSRP ÷ Electric Range

    - `Region` based on U.S. Census categories

    - `Is_Electric`, `High_Range_EVs` (Range > 200 miles)

Univariate Analysis

- Electric Range: Right-skewed distribution; BEVs dominate in higher range (>200 miles).
- Base MSRP: Wide spread; BEVs generally priced higher.
- Price_per_Mile: BEVs offer better value per mile.
- Vehicle Age: Most vehicles are recent (post-2018). And BEV vehicles can be used for long-run (even after 10 years).

Bivariate Analysis

- Key Correlations

BEV vs. PHEV Comparison

Range: The electric range of BEVs is strongly correlated with MSRP, while the correlation is low in PHEVs.

Price: BEVs cost more upfront but provide better price efficiency per mile

- Scatter plot confirms that as electric range increases, the price per mile drops significantly. So, PHEVs are low-efficiency and high cost.
- PORCHE vehicles are most expensive and low electric range.
- TESLA and KIA are most cost efficient and provides high range and low MSRP.

Multivariate Analysis

- Base MSRP with Price_per_Mile have positive correlation (higher MSRP trends to results in higher cost per electric mile).
- Electric Range with price per mile has negative trend (longer range EVs offer better value).
- MSRP with Electric range- Weak trend (high priced cars doesn't guarantee range)
- Vehicle Age with others has no correlation (Age is not a key factor in pricing or range in this data)

PIVOT Table

- analyzes the model year with Base MSRP and Electric Range.
- Most PHEVs have short electric ranges but vary widely in price.
- BEVs started premium vehicles with long ranges.

Conclusions

- High Electric range for BEV
- High Base MSRP for PHEV but low range
- High Price for PHEV than BEV
- Western region leads in EV adoption (highest number of BEVs (nearly 2000) and PHEV (nearly 1250))
- Top EV makers are TESLA , KIA, BMW, VOLVO and MINI.

Recommendations

- Expand charging infrastructure in underrepresented areas.
- Consider price subsidies or tax incentives for lower-cost BEVs.
- Promote awareness around CAFV eligibility.