To: Lex Luther, CEO, Janzen Consulting Group

From: Data Analysis Team

Date: October 1, 2024

Re: Analysis of Electric Vehicle Population Data in Washington State Department of Licensing (DOL).

Dear Mr. Luther,

We have analysed the electric vehicle population data currently registered through the Washington State Department of Licensing (DOL)[1] to inform our consulting strategy for clients in the automotive and energy sectors. This analysis will help determine if there is any difference between electric vehicle type and recorded electric range. The observation from this analysis points to crucial details that have significant implications for EV adoption within Washington state.

Our analysis focuses on the electric vehicle type regardless of the make or region and identifies if there is any difference in the observed ranges. Our main goal is to measure any statistical difference between Battery Electric vehicles and Plug-in-hybrid electric vehicles in terms of observed ranges.

The key takeaways are as follows:

1. The maximum observed electric range is 337 miles.
2. Battery electric vehicles have a longer range than plug-in hybrid vehicles.

Univariate Analysis

There are 2 types of electric vehicles, and the data is heavily skewed towards Battery electric vehicles, having 78% of the observations. From the summary data of the range variable, we find that outlier observations of 0 (zero) miles were recorded. This is because Battery Electric vehicles purchased in 2021 and later don't have a recorded observation for electric range in the dataset.

Distribution of Electric Vehicle Type

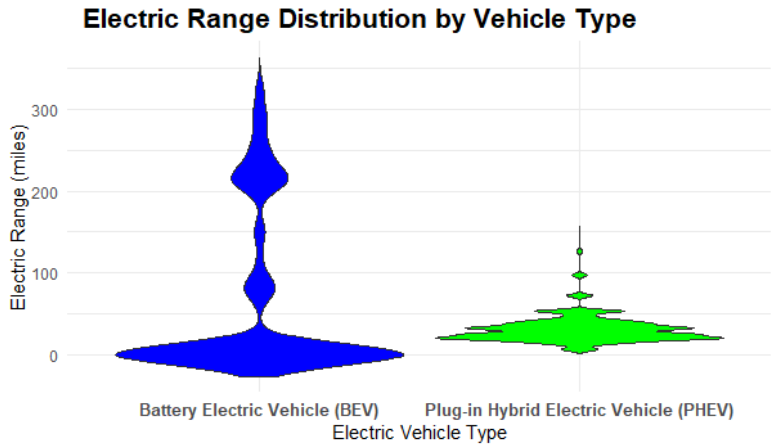
Electric Vehicle Type	N	PCT
Battery Electric Vehicle (BEV)	130293	78.1%
Plug-in Hybrid Electric Vehicle (PHEV)	36507	21.9%
Total	**166800**	**100.00%**

Summary Statistics for Electric Range

N	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum	SD
166800	0	0	0	61.5	84	337	93.3

Bivariate Analysis

The violin plot helps visually compare the distribution of the electric range across the two types. If we disregard the distribution of cars along the 0-mile point, the widest distribution of Battery Electric vehicles around the 200-mile mark suggests that most of these types of vehicles have an electric range of above 200 miles. Similarly, the widest distribution in plug-in hybrid electric vehicles around the 25-mile mark suggests that these types of vehicles have an electric range of less than 50 miles. This is typical of hybrid vehicles as they depend on gasoline engines to support the overall mileage range of the vehicle.



[1] Data.gov. (2024, August 16). *State of Washington - Electric vehicle population data*. https://catalog.data.gov/dataset/electric-vehicle-population-data

Hypothesis

We are testing to see if there is any difference in observed electric ranges between electric vehicle types. Therefore, the null hypothesis for this research would be "There is no difference in observed ranges between Battery Electric Vehicles and Plug-in Hybrid Vehicles." The alternative hypothesis would be "There is a difference in observed ranges between Battery Electric Vehicles and Plug-in Hybrid Vehicles."

$H_{0:}\ R_{bev} = R_{phev}$

$H_a: R_{bev} \neq R_{phev}$

Although the number of observations indicates that a Z test would be more suitable, at higher observation quantities, the t-test score comes close to the Z test scores and therefore is more reliable for testing the hypothesis. Since we are choosing to see if there is only a difference, we chose the two-tailed t-test Upon conducting the t-test with an alpha of 0.05, we got a t-score of 72.54 and a p-value significantly smaller than the considered alpha. This indicates statistical significance in the difference in observed electric ranges and therefore we proceed to reject the null hypothesis.

$t(166{,}798) = 72.545,\ p < 0.05$

Interpretation

Upon conducting statistical tests, we have observed statistical significance. However, before we can make any conclusions on the data, we check substantive significance and conduct standardized effect size tests and power tests.

A Cohen's d test conducted has given a value of 0.43 which can be interpreted as a medium-sized difference ($0.43 \approx 0.5$) under the thumb rule. With a power test result of 1, we can conclude that there is a significant relationship between electric vehicle type and observed electric range.

Conclusion

A major takeaway from this analysis revealed that there is a difference statistically and substantively, between Battery Electric Vehicles and Plug-in hybrid vehicles in their observed Electric range. Also, we have learned that plug-in hybrid electric vehicles have most of their electric ranges observed around 20-50 miles. Therefore, we recommend incentives for BEVs as they offer higher electric ranges and conform to potential future environmental policies (emissions regulations).

Symbols

H_0 = Null hypothesis

H_a = Alternative Hypothesis

R_{bev} = Electric Range of battery electric vehicles

R_{phev} = Electric Range of battery electric vehicles