605.662 Data Visualization

Project 3 - Interactive Visualization using Tableau

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1 Introduction

In the last twelve years, the electric vehicle (EV) market has exploded from a project funded by the Department of Energy[1] to a wave of societal advancement as more consumers find reasons to make the switch to electric.

The most popular reason to switch to electric, answered by EV owners in 2018, is because of environmental concerns.[2] Many states and counties offer subsidies and tax benefits on EVs for the same reason. Next is because of the lower cost of ownership, since electricity is cheaper than gasoline and EVs do not require as much maintenance, such as an oil change. Lastly, another incentive to switch to electric is access to the HOV lane on highways since many states have adopted this exemption to encourage consumers to buy EVs.

As trending shifts in consumers' tastes and preferences align with environmental consciousness and more EVs find their way onto public roads, it is important for car producers and consumers to be able to compare how each brand is performing in the EV market.

2 Dataset

The data[3] represents the Battery Electric Vehicles and Plug-in Hybrid Electric Vehicles that are registered through Washington State Department of Licensing (DOL) as of February 25, 2022.

A Battery Electric Vehicle (BEV) is an all-electric vehicle using one or more batteries to store the electrical energy that powers the motor and is charged by plugging the vehicle in to an electric power source. A Plug-in Hybrid Electric Vehicle (PHEV) is a vehicle that uses one or more batteries to power an electric motor; uses another fuel, such as gasoline or diesel, to power an internal combustion engine or other propulsion source; and is charged by plugging the vehicle in to an electric power source.

The variables of interest for this assignment are ZIP code, model year, make, model, electric vehicle type, CAFV eligibility, electric range, and base MSRP. It should be noted that the variable "vehicle location" is the latitude and longitude of the center of each ZIP code, so no additional information is contained in that variable that is not contained in ZIP code.

Clean Alternative Fuel Vehicle (CAFV) eligibility is based on the fuel requirement and electric-only range requirement to be eligible for Alternative Fuel Vehicles retail sales and Washington State use tax exemptions. Sales or leases of these vehicles must occur on or after August 1, 2019 and meet the purchase price requirements to be eligible for Alternative Fuel Vehicles retail sales and Washington State use tax exemptions.

[1] Matulka, Rebecca. "The History of the Electric Car." Energy.gov.
[2] Valdes-Dapena, Peter. "More Americans Say They'll Buy an Electric Car." CNNMoney.
[3] "Electric Vehicle Population Data." Data.WA.gov.

Variable	Data Type	Min	Median	Max	Avg	Std	Mode	Description
VIN (1-10)	Nominal	-	-	-	-	-	5YJYGDEE9M	The 1st 10 characters of each vehicle's Vehicle Identification Number (VIN).
County	Nominal	-	-	-	-	-	King	The county in which the registered owner resides.
City	Nominal	-	-	-	-	-	Seattle	The city in which the registered owner resides.
State	Nominal	-	-	-	-	-	WA	The state in which the registered owner resides.
ZIP Code	Nominal	-	-	-	-	-	98052	The 5 digit zip code in which the registered owner resides.
Model Year	Ordinal - Numeric	1993	2018	2022	2018.02	2.68	2021	The model year of the vehicle, determined by decoding the Vehicle Identification Number (VIN).
Make	Nominal	-	-	-	-	-	Tesla	The manufacturer of the vehicle, determined by decoding the Vehicle Identification Number (VIN).
Model	Nominal	-	-	-	-	-	Model 3	The model of the vehicle, determined by decoding the Vehicle Identification Number (VIN).
Electric Vehicle Type	Nominal	-	-	-	-	-	Battery Electric Vehicle (BEV)	This distinguishes the vehicle as all electric or a plug-in hybrid.
Clean Alternative Fuel Vehicle (CAFV) Eligibility	Ordinal - Binary	-	-	-	-	-	Clean Alternative Fuel Vehicle Eligible	This categorizes vehicle as Clean Alternative Fuel Vehicles (CAFVs) based on the fuel requirement and electric-only range requirement in House Bill 2042 as passed in the 2019 legislative session.
Electric Range	Quantitative - Ratio	6.00	125.00	337.00	139.41	97.76	215.00	Describes how far a vehicle can travel purely on its electric charge.
Base MSRP	Quantitative - Ratio	$28,500.00	$52,900.00	$845,000.00	$52,537.70	$22,646.71	$69,900.00	This is the lowest Manufacturer's Suggested Retail Price (MSRP) for any trim level of the model in question.
Legislative District	Nominal	-	-	-	-	-	45	The specific section of Washington State that the vehicle's owner resides in, as represented in the state legislature.
DOL Vehicle ID	Nominal	-	-	-	-	-	479254772	Unique number assigned to each vehicle by Department of Licensing for identification purposes.
Vehicle Location	Nominal	-	-	-	-	-	POINT (-122.122018 47.678465)	The center of the ZIP Code for the registered vehicle.

3 Analytical Questions

- Which regions in Washington have the highest number of EVs?
- What is the most popular make and model of EVs in Washington?
- How do EV producers compare in electric range and base MSRP?
- How do electric range and base MSRP change as model year increases?
- How do BEVs and PHEVs compare in terms of electric efficiency?

4 Design

My dashboard[4] shows three visualizations; a population map, an area chart, and a parallel coordinates chart; and updates on four global filters: model year, make, electric vehicle type, and model.

The population map shows the geographic distribution of EVs that are registered through the Washington State DOL. The map shows large dots centered on ZIP codes with high EV population and small dots centered on ZIP codes with low EV population. The dots are semitransparent so that areas with high EV population density are a darker shade than less dense regions. The scale of the dots as a whole is static and does not change when less EVs are included in the population through global filters. The color of the dots hold no significant meaning. While it is possible to pan and zoom the map to view different regions of the globe, I chose to focus the map on the state of Washington because there are not a significant number of EVs registered through Washington State DOL where the owner resides in a state besides Washington or Northern Oregon.

[4]Cinkle, Sloan. "cinkle_project03."

The area chart shows the distribution of model year, make, and model of the EV population registered through Washington State DOL as of February 25, 2022. Each area of color represents a specific manufacturer of EVs, and each area contained within darker borders represents a model from the manufacturer which can be seen by hovering the cursor over that area. The most popular make appears below the less popular ones, and popular models within their make lie below less popular within the same make. By hovering over a specific model year and model on the graph, one can also view the accumulated population of the model for all model years up to the selected year. This can be useful for observing the total population of a model by hovering over the model year 2022.

Last but not least, the parallel coordinates chart shows how each model of EV in the data compare to one another on several descriptive statistics: average model year, proportion of BEVs, average electric range, proportion of CAFV eligible vehicles, and average base MSRP. The order of these variables was constructed to show interesting relationships between each adjacent pair of variables. Comparing model year with the proportion of BEVs shows how EV technology has evolved over time. Comparing the proportion of BEVs to average electric range shows how BEVs and PHEVs compare in terms of electric efficiency. The relationship between average electric range and proportion of CAFV eligible vehicles shows how the requirement for CAFV splits EVs based on their electric efficiency. Lastly, the relationship between CAFV eligibility and average base MSRP could provide insight to whether consumers are willing to pay more in order to receive CAFV benefits.

Use of the four global filters on the top-right of the dashboard update all visualizations provided, and each filter updates to only include relevant values based on other filters. The model year filter is a slider to select a range of years within all years on record. The electric vehicle type filter is a single choice list that lets the user choose one of three options: all vehicles, BEVs, or PHEVs. Both the make and model filters are multiple selection lists that allow the user to specify certain EV manufacturers and model types that they wish to compare directly on the visualizations. The values in these filters are sorted by popularity, and the filters contain to search for makes or models since the data includes such a wide variety of vehicles.

5 Discussion

Before any other discussion takes place, a very important fact that should be known by anybody using this dashboard is that the data includes not only EVs that were sold on the market by manufacturers, but also regular emission vehicles which have had their engines and related components replaced with EV parts. These vehicles qualify as EVs by all means and are registered legally through the Washington State DOL; however, in order to compare how brands perform within the EV market, it is recommended to keep the left-bound model year filter on at least 2003 to observe mostly vehicles that were sold on the EV market. No EVs exist in the data for years 2003-2007, and only a small amount of EVs exist for years 2008-2011 (all Tesla Roadsters), up until other brands started to mass produce EVs for public consumption.

My visualizations attempt to answer all of the analytical questions posed above in different ways. First, the regions of Washington that have the highest number of EVs are shown by the population map. It is evident that there are a few hotspots for the EV population in Washington, most notably the greater Seattle area containing Everett and Tacoma, the southwestern corner of Washington just north of Portland, Spokane, and the westernmost area of the Canadian border just south of Vancouver. Most other parts of Washington have only a few EVs in each ZIP code.

The most popular make of EV in Washington, is Tesla, by far, followed by Nissan and Chevrolet. The most popular models of EV in Washington are Tesla Model 3, Nissan Leaf, Tesla Model Y, Tesla Model S, and Chevrolet Volt. It appears that Tesla currently has a stronghold of the EV market while other brands seem to be trying to keep up. With the area chart, we can see that the two biggest jumps in EV population based on model year are 2018 – one year after Tesla releases the Model 3

– and 2021 – one year after Tesla releases the Model Y. The chart shows that these jumps in EV popularity are almost entirely weighted on the success of these newly released models.

We can answer how EV manufacturers compare regarding electric range and base MSRP with the parallel coordinates chart. By either hovering over individual lines or applying a global filter for a select group of manufacturers, we can compare the average statistics for the models of a brand. In general, it appears that Tesla, Hyundai, and Chevrolet models tend to perform well in electric efficiency compared to others. Models from Kia, Hyundai, and Toyota seem to be the most affordable while Porsche, Tesla, and BMW models tend to be more expensive.

It is not evident that model year has any type of association with electric efficiency from the parallel coordinates chart. We can see that model year has almost no relation to proportion of BEVs, but the proportion of BEVs has an almost perfect cutoff value based on electric range. This signals to me that electric range does not depend solely on model year, but it still is possible that there could be an association including model year and electric range with electric vehicle type as a secondary explanatory variable.

BEVs outperformed PHEVs heavily on electric efficiency. Based on the parallel coordinates chart, we can see that every model which consists of only BEVs has higher electric range than every model which consists of only PHEVs. We can also see that there is a similar, lower cutoff for CAFV eligibility as there is for BEVs, so we know that all BEV models in this data are also CAFV eligible due to their high electric range.

6 References

1. Matulka, Rebecca. "The History of the Electric Car." Energy.gov. Department of Energy, September 15, 2014. https://www.energy.gov/articles/history-electric-car.

2. Valdes-Dapena, Peter. "More Americans Say They'll Buy an Electric Car." CNNMoney. Cable News Network, May 8, 2018. https://money.cnn.com/2018/05/08/technology/aaa-electric-car-consideration/index.html.

3. "Electric Vehicle Population Data." Data.WA.gov. Department of Licensing, January 24, 2022. https://data.wa.gov/Transportation/Electric-Vehicle-Population-Data/f6w7-q2d2.

4. Cinkle, Sloan. "cinkle_project03." Tableau Public, March 6, 2022. https://public.tableau.com/app/profile/sloan.cinkle/viz/cinkle_project03/EVPopulation.