

Visualization of change in EV trend in USA over the last Decade

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Data Visualization (DATA-230)

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Abstract

The Electric Vehicle (EV) market in the United States of America has seen a considerable spike over the last decade. This project aims to investigate the reason for this change in trend of electric vehicles and plug-in hybrid vehicles. It also tries to identify how few factors such as fuel prices, change in median income and incentives provided by the state governments impact consumers choice to choose an EV. Additionally, it also shows the popular choice of consumers.

The project uses certain data visualization tools to show the complete picture on how EV adoption has evolved in the last 10 years. It aims to have an interactive dashboard which provides information on different geographies in the USA at different time space. In addition to the popular choices of consumers it also tried to summarize a few basic features of the electric car.

The expected outcome of this analysis is to clearly visualize the trend change in EV market, contribution of fuel prices, change in median income and additional state incentives offered in adopting EV’s and the popular choice of consumers and the factors contributing to this choice. Overall, the project provides information to the auto manufacturers and the future consumers on all-round view of the EV market in USA, moving towards sustainability in terms of electric mobility.

Introduction

Background

The future of the automotive industry in the USA is based on alternative fuel vehicles. The Electric Vehicles are emerging as a great force in this transition. The world is facing environmental challenges such as global warming and a primary contributor for this to this increase in the carbon content in atmosphere is due to the carbon emissions from petrol/diesel-based vehicles.

The United States of America is also home to many auto-manufacturers who are working on this front.

Over the last decade, certain factors such as development in battery technology, improvement in charging infrastructure, reduction in time to recharge an EV, federal laws to allow EV’s to use HOV lanes, change in fuel prices, increase in income of people, benefits provided by federal and state government in form of rebates and subsidies have influenced the consumer choices and has accelerated the electric vehicle revolution in USA.

The data sources used for this project is that of the EV population data over last decade from Kaggle and the incentives provided by each state was taken from few governments and Tesla’s official website. The median income of people over the last decade was collected from the Federal website. Finally, the fuel prices were got from the Energy information administration government site.

Implementation

Below are the steps followed for implementing this project.

A diagram of a process

Description automatically generated

1. Data Collection

The primary step to visualize the change in use of EV’s is to collect meaningful data. This data must contain information on the EV’s, and plug-in hybrid cars sold in the USA in the last 10 years. This sales data must contain the type of vehicle purchased, the model of the vehicle, the year it was manufactured/sold, EV tax credit/ rebate eligibility, the MSRP of the vehicle, the maximum miles that can be driven by the vehicle with maximum charge, the county and state the car was sold in etc.

Next, we need the data regarding the factors we want to analyze and visualize through our visualizations that have contributed to this trend.

Further, we collect the change in average fuel prices data in each state of the USA from the year 2013 to 2023.In this data, we have the average fuel price in a particular state over the entire fiscal year. Additionally, we collect data on the incentives provided by each government in addition to the federal incentive for any EV purchase in that state.

Furthermore, we also try and analyze the contribution of change in median income of people, which needs the average median income each year since 2013 in every state of USA. This data has information on the income each person is assumed to have in each year specific to a state.

1. Data Cleaning

We load the dataset and check if the data is appropriate and contains sensible and correct data for interpretation. We need to check if data across the entire column is consistent. If not, we can work on the data and convert it to understandable and required format. Additionally, we can also transform the existing data into specific columns to understand and visualize the cases in detail and specific. We observe that for a few columns the base MSRP of the car is 0 which is incorrect. To correct this, we impute the ones with 0 MSRP with the price of the same car in general or we impute it with the mean of the MSRP of cars which belong to that specific model. Next, we divide the entire location column into separate columns like State and County which helps us get a better insight on the change in trends at a state level.

Next, we trim the fuel prices of all states just to have 2 decimal places for consistency. We also transform the data to the needed format where each column has fuel prices corresponding to a specific state in that specific year. The same format is followed for the median income dataset and data is transformed. In the incentive by state dataset, the maximum incentive provided by each state for an EV purchase only in the form of tax credit is considered.

Tools like excel, python libraries like pandas and a few features of Tableau Prep builder are utilized.

1. Loading Data

The first and the utmost important step for visualizing the information present in any data is to load the data in the needed format into the visualization tool used. All the 4 different data sets must be clubbed together using the joins features of Tableau.

A diagram of a company

Description automatically generated

The data from all 4 different sets are joined together using joins. An inner join is used because we need data from all sets even if data is not present in another set. are used to join the data from all 4 datasets. Post joining, we have the data in a usable format, and we also have all the required data to pictorially represent and understand what the data is trying to convey and can draw conclusions from the collected data. The data is extracted on to tableau local which means that any changes made on the .csv or .xls files will not be reflected.

Once extracted, the tableau software automatically generates a few calculated fields such as latitude and longitude fields from the state column present in the input data. It also generates few dimensions and few measures which help us visualize better. All the categorial data in the dataset are created as dimensions and the numerical data we have are all used as measures. These generated fields can be used to visualize the raw data and draw meaningful insights and conclusions from the dataset.

1. Analysis
2. EV sales over the last decade

A graph with red and purple lines

Description automatically generated

We observe that there is a significant surge in the sales of EV in general over the last decade. The above graph shows the change in counts of compete electric and the plug-in hybrid cars. We see that in 2013 there are around 2000 cars in plug-in and 2500 electric car. While in 2023 we see almost 10 times increase in electric cars and around two times in plug-in hybrids.

A graph with blue and orange lines

Description automatically generated

The above graph depicts the forecast of sales in the following year. It shows an increase in the EV cars sold over the next year but the count of plug-in hybrids is almost constant as the current year.

1. EV count

A graph with numbers and a bar

Description automatically generated

The graph shows the number of EV’s present in each state of USA. We see that the maximum number of cars is present in California followed by Washington. Also, the least number of EV’s are in Wyoming. There are around 24000 cars in California and around just 1800 in Wyoming.

1. Change in Median Income of People

A graph with a line going up

Description automatically generated

The above graph depicts how the median income of an individual has changed over the last decade. An upward trend can be observed from 2013 till 2023. The Average median income in 2013 was about 65K which was around 80K in 2023.

We also can infer from the graph that the income of people will increase over the course of the next few years. This trend can have an impact on the sales in the automotive industry.

1. Incentives provided by the State for an EV purchase.

A screenshot of a graph

Description automatically generated

The federal and state government provides an incentive to every EV purchased to reduce the carbon emissions in the country. This also enhances a movement towards sustainable development and reduces one’s contribution towards global warming. The representation above shows the rebate in terms of tax credit each state government provides for an EV purchase. The state with higher incentive is darker compared to the ones with less or no incentives provided by the state.

1. Increase in Fuel Prices

Another aspect which might have a contribution in people choosing an electric vehicle over a petrol/diesel run vehicle is the maintenance cost involved after owning the vehicle.

A graph showing the growth of a company

Description automatically generated

The graph above shows the change in the average fuel prices in the United States of America. We see there is an increase of fuel prices per gallon over the last 10 years. We observe that the prices of gasoline have increased from being $2.9 in 2013 to almost $ 4.5 per gallon in 2023.

We try to forecast the fuel prices for the following years as below:

A graph showing the growth of a company

Description automatically generated

The forecast shows that fuel prices will increase in the following years. Additionally, we also observe a linear trend line for the fuel price over the last entire decade and the line seems to grow for the near future.

1. Highest SOLD EV’s

The chart below shows the most sold EV’s in the last decade. The sales are depicted with both size and color in the chart. The maker of the maximum sold EV’s is both larger and dark in color.

A screenshot of a computer screen

Description automatically generated

The above chart shows that Tesla is the most sold EV over the entire decade followed by Nissan and Chevrolet. Tesla almost accounts for around above 35% of the total EV cars sold in the last decade.

1. Credit eligibility of EV’s based on its electric range.

A graph of different colored bars

Description automatically generated

A pie chart with text

Description automatically generated

The graph above shows the count of EV’s which were eligible to receive the federal tax credit based on its electric range (represented in blue). A few EV’s needed a little extra detail (shown in orange) from the maker on the for the EV’s to receive a tax credit. Another set of cars represented in ed are the ones which are not eligible for any credit due to low electric range.

1. EV range and its MSRP

The below graph shows the features of EV’s. It shows the base MSRP of the A group of purple circles with white text

Description automatically generated

maker which is represented by the color. The electric range is shown as the size of the bubble. The darker the bubble the more expensive the car is. In general, consumers would prefer a large bubble but has a lighter share.

1. Map

A map of the united states

Description automatically generated

The map shows all the states in the USA with EV’s are used. The color shows the count of EV’s in USA. The state which has a dark color has more EV’s compared to the states which are light in color.

1. Interactive Dashboard

A close-up of a graph

Description automatically generated

The EV trend dashboard tries to highlight all the key features of the analysis. It provides a comprehensive and valuable overview of the dynamic landscape of the EV industry over the last 10 years. Scrolling through the different sections of the dashboard reveals several important trends and patterns that allow for a deeper understanding of how our industry has evolved over the past few years. It provides a correlation between all the factors considered such as increase in fuel price, change in median income of an individual, the incentives and rebates provided by the federal and local agencies. It also highlights the reasons why few cars were sold in higher numbers in comparison to others in the lot. It also sheds light on if all cars of all makers were eligible for the tax rebate irrespective of being electric. Additionally, it elaborates on the change in trend in each state of the USA. It shows the counts of EV’s in each state and how each state has adapted to this trend and the reasons influencing consumer behavior. It also sheds light on the change in the automotive industry stepping towards green revolution and sustainability. Also, it acts as proof of innovation and technology in the automobile sector. It has a few interactive elements, such as a map and makes of highest EV that help us drill down the numbers and draw conclude or insights from the data.

Test Cases on Dashboard

1. Test the drill down and filtering on the map.

A screenshot of a computer

Description automatically generated

We observe that the drill down is working and all the graphs are adapting to show the data for Texas.

Similarly, the drilldown in the make fields also is working showing the details only in regard to makers of the car. It shows the eligibility of these cars and gives out details such as if all models of this maker are eligible for the tax credit.

A screenshot of a computer

Description automatically generated

Additionally, the filtering on year also is working as expected as below:

A screenshot of a computer

Description automatically generated

1. Checking the axes and label’s for all the visualizations

All the visualizations have the needed axes labels and legends are also appropriate.

1. Cross-checking the titles present on dashboard with the expected analysis needed.
2. Testing and validating the over all interactivity of the dashboard.

Use Cases on Dashboard

The use cases of the dashboard are:

1. Policy Makers must continue to support EV adoption through incentives.
2. Consumers are embracing and must continue choosing or plug-in hybrids for a sustainable future.
3. Manufacturers must invest more on innovation in technology where the car prices can further be reduced. They also must work on improving the charging infrastructure all over the country to increase their sales.

Conclusion

The interactive dashboard created for the EV market trend analysis over the last decade provides meaningful insights into the EV automotive industry. We can observe and draw many insights as we navigate through each section of the final dashboard. It answers few key answers such as the change in trending a certain geography. The factors that could have had the influence and how these factors have changed over the years. It also shows which car manufacturers have had the highest sales and the reasons for their sales. It also shows that these manufacturers have invested a lot in battery technology and charging infrastructure in order to achieve the electric range for that base price.

Conclusions and recommendations that can be viewed from this dashboard are:

1. Policy Makers must continue to support EV adoption through incentives.
2. Consumers are embracing and must continue choosing or plug-in hybrids for a sustainable future.
3. Manufacturers must invest more on innovation in technology where the car prices can further be reduced. They also must work on improving the charging infrastructure all over the country to increase their sales.

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