**Final Project**

**on**

**Leading the Charge with Electric Vehicles**

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**Introduction**

An Electric Vehicle is an automotive vehicle that uses one or more electric motors for propulsion. They can be powered with an extravehicular source, autonomously by a battery or by converting fuel to electricity. All forms of electric vehicles can help improve fuel economy, lower fuel costs, and reduce emissions. Research has shown that electric cars are better for the environment. They emit fewer greenhouse gases and pollutants as compared to petrol or diesel cars.

What are the benefits of electric cars?

* They produce no tailpipe emission.
* They are cheaper to run as compared to the gasoline cars.
* They have fewer moving parts, hence less maintenance required.
* They often provide a better driving experience than petrol/diesel cars.

The uptake in electric vehicles is occurring faster than previously thought, majorly driven by government decarbonization policies, falling battery prices and a growing number of models offered by automakers combined with good features. Electric Vehicles in the world are growing slowly. Although the car market is dominated by gas, each year EV becomes more popular. The world is continuously setting ambitious goals for EV and the global electric market has taken a huge leap towards EV and we can expect the trend to accelerate potentially.

The following visualization answers the following questions:

* Who drives the most in the world and do these countries boast the largest proportion of electric vehicles?
* Which countries have the most charging outlets?
* Is battery price one of the reasons for boom in EV sales?
* Which US states are leaders in the EV space and who are the most popular manufacturers?
* Which EV manufacturer is at the forefront to provide affordable vehicles with highest average battery efficiency and range?

**Methodology:**

Table name: “Vehicles per Capita”

Wikipedia.com was sourced to find the vehicles per capita for the year 2020 and web scraped using Beautiful Soap library in Python to find the number of motor vehicles per 1000 inhabitants for 2020. The data includes cars, buses and other trucks but excludes motorcycles and other two-wheelers. After the raw data was pulled, the data was cleaned using Excel to remove special characters.

Table name: “Countries with EV market share”

Electric car use by country varies worldwide and this data is used to observe the market share trends of Electric Vehicles in 2020 for major countries and regions in the world. The data is sourced from Wikipedia and web scraped using Beautiful Soap. The raw data was cleaned to remove special characters and remove unwanted columns.

Database or Table name: “Reg-State-wise”

Alternative Fuels Data Center (AFDC) is an arm of U.S. Department of Energy that provides information and data for decision makers to reach their energy and economic goals. AFDC was sourced for the data on electric vehicles registrations by state in the United States. The data was first analyzed to pick out few states with significant EV registrations. The data was then processed through Tableau Prep Builder to remove unwanted columns and null values. The multiple tables for different states were then combined using the union operation on the Prep Builder to collect the data for the years 2015 and 2020. The two tables were then joined in Tableau for analysis.

Database or Table name: “Electric Data (2)”

The table was sourced from Kaggle, and it includes all the electric car models in the European and US markets. The data was first cleaned using the Tableau Prep Builder to remove missing values. The data is used to study the various features of an electric car to analyze the relationship between efficiency, range, and vehicle price.

Database or Table name: “EV Sales and Battery”

The tables in the excel consist of data on Global EV sales and Lithium battery price from 2010 through 2020. The data in the tables were sourced from International Energy Agency website. The global sales data consists of sales data from 2010 to 2020 for certain countries like USA, UK, Japan, Canada, and rest of the world. The sourced data was initially cleaned in Tableau Prep Builder to remove missing values and unwanted columns. The two tables were then linked in Tableau for analysis.

Table name: “Output”

The data was sourced from data.world to visualize the various electric station charging locations in the world. The data was initially cleaned in Excel to remove special characters and then processed using Prep Builder to remove missing values.

**Analysis:**

**Who drives the most in the world and do these countries boast the largest proportion of electric vehicles?**

Map

Description automatically generated

The visualization is a simple comparison for various countries on the number of vehicles per 1000 people. With increase in the color intensity, the above map visual indicates increase in vehicle consumers per capita. Following the low population of Andorra that has more than 1:1 ratio of person per vehicle, New Zealand (837), the United States (816), European countries like Iceland (866), Finland (790) and Italy (663) have the distinction of having the most motor vehicles per 1000 people. The European countries like Germany (574), Norway (522), Netherlands (499) follow suite.

Chart

Description automatically generated

Europe, being one of the largest consumers of vehicles, are also the biggest consumers of electric vehicles as well. The above chart depicts the market share of electric vehicles in countries that have the highest demand for vehicles. The chart uses a dual axis to also visualize the total percentage of electric vehicles on road.

Scandinavian countries like Norway and Sweden have highest population of electric vehicles globally. Norway stands at a staggering market share of 86% which means that 86% of the total cars sold were electric out of which 22% were pure electric.

Although the United States has the most motor vehicles per capita, only 4% of them are electric. However, California, a state in the U.S., has a market share of 12.8% which is greater than the national market share for electric share.

**Which countries have the most charging outlets?**

Chart, bubble chart

Description automatically generated

The above chart displays the count of charging stations spread across the globe. The data here is displayed in the form of a bubble chart where the bubbles indicate the different countries, and the size of the bubble depicts the spread of charging stations in that region. The chart is filtered to show the top 10 countries with the highest charging locations.

With growing popularity and number of increasing EV startups in the US, it has the highest number of charging outlets close to 32,000. The European countries like Germany, United Kingdom and France closely follow suite. Going by the observation, Norway should increase the number of charging stations as it is one of the dominant forces in the EV business.

**Is battery price one of the reasons for boom in EV sales?**

Chart, scatter chart

Description automatically generated

The chart above gives an insight into the EV sales and lithium battery costs trends over the years from 2010 to 2020.

The graph above is a scatter plot with data points indicating the battery price and size of the circles showing the EV sales. With growing popularity and demand for EVs, we can see that the battery prices were higher at about $924 per unit since lesser number of EVs were in demand. Over the years, there is a dramatic cost decline in battery price which amounts to $137 per unit due to higher number of EVs in the market with over a 5 million EVs sold over a period of 10 years.

**Which US states are leaders in the EV space and who are the most popular manufacturers?**

Chart

Description automatically generated

The above bar chart gives a comparison on the count of EV registered vehicles for states with major EV sales like California, Colorado, Florida, Michigan, New Jersey, New York, and Texas in the United States. The year 2015 shows the initial trends of EV popularity with California having the highest number of registrations. The other states had lesser registrations in comparison. As years passed by, Colorado has gained momentum to become a state with one of the highest EV registrations of 400k followed by Texas and Florida whereas California has a seen a dip with just 7k registrations.

Chart, bar chart

Description automatically generated

The above graph visualizes the major players in the United States EV market with respect to the EV registrations. It does not come as a surprise that Tesla is the leader in the EV space for 2020 that has the highest top two registrations for Tesla Model 3 and Model S closely followed by Nissan Leaf. Tesla model 3 registrations eclipse the combined registrations of Tesla Model S and Nissan Leaf. Also, Tesla model registrations constitute for the 3 spots amongst the top 5 of the total EV registrations.

**Which EV manufacturer is at the forefront to provide affordable vehicles with highest average battery efficiency and range?**

Chart, bar chart

Description automatically generated

The above graph classifies manufacturers based on battery efficiency for different body styles. The manufacturers are drilled down to their respective vehicle models to show the vehicle battery efficiency. A filter is applied on the body style to display efficiency for Hatchback, Sedan, and SUV.

Nissan provides the highest average battery efficiency of 194 WhKm for the Hatchbacks followed by CUPRA with 181 WhKm. For the Sedans, Porsche gives the highest battery efficiency of 207.5 WhKm closelu followed by Audi at 197 WhKm. Going by the observations, although Byton and Jaguar score high in efficiency for SUVs, efficiency for Audi is comparable at 228 WhKm. Although Tesla is a dominant force in the EV domain, its average battery efficiency is substandard which is the lowest for Sedan at 160 WhKm and average when it comes to SUVs.

Chart, histogram

Description automatically generated

The chart here displays the average range for different brands in comparison to their average price using a dual axis graph. The data for only SUV, Sedan and hatchbacks is displayed using a filter. The average price is given by the line chart whereas average range for the vehicles is depicted using a bar chart.

Here we can observe that Tesla provides one of the best price-to-range ratios for Sedans and SUVs at 137 and 182 respectively. On the other hand, Audi has the lowest ratio for SUVs at 215 and for Sedans at 294 respectively with Audi models being the priciest. For the Hatchbacks, CUPRA, Nissan and Volkswagen are the top 3 affordable brands that provide good mileage.

Graphical user interface, application

Description automatically generated

The above chart displays average powertrain efficiencies. Powertrain constitutes of batteries, motors and other moving components that deliver power to the wheels. Front wheel drive (FWD), Rear Wheel Drive (RWD) and All wheel drive (AWD) indicate the type of drive. Amongst the 3, AWD is the most efficient with the average efficiency of 206 WhKm since motors are installed on both the front and rear axle which drive all 4 wheels.

RWD and FWD have comparable average efficiencies since they have just one motor installed on the rear and front axle respectively.

**Conclusions:**

Who drives the most in the world and do these countries boast the largest proportion of electric vehicles?

USA drives the most vehicle population in the world, but it does not constitute the largest proportion of electric vehicles.

Which countries have the most charging outlets?

USA has the most charging outlets.

Is battery price one of the reasons for boom in EV sales?

Yes, decrease in battery price could be one of the factors for boom in EV sales.

Which US states are leaders in the EV space and who are the most popular manufacturers?

California in 2015 and Colorado in 2020 are the leaders in the EV space. Tesla is hands down the most popular EV manufacturer in the US.

Which EV manufacturer is at the forefront to provide affordable vehicles with highest average battery efficiency and range?

Tesla manufactures EVs at affordable vehicles with highest battery efficiency and range.

**Research questions:**

1.What could be other reasons for increase in EV sales?

2.Why does US not have the best EV market share despite having the best vehicle per capita and highest charging locations?

References:

<https://www.kaggle.com>

<https://www.iea.org/>

<https://afdc.energy.gov/>