Global Fusion of Nascent Technologies in Next -Generation Electric Vehicles Models: Evolution, Developments and Regulatory Prospects

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Abstract: Due to its potential to have the lowest carbon footprints on the planet, electrical vehicles, or EVs, have drawn a lot of attention globally in the period of moving towards greener and zero-emission energy generation and transportation. Climate change is currently seen as one of the main negative consequences of burning fossil fuels and traditional modes of transportation. Because Renewable Energy Sources (RESs) are variable and electric vehicles (EVs) are one of the primary means of increasing them, electrifying energy consumption is one of the most important aspects of the energy transition when considering the replacement of conventional plants with RE. This study had a comprehensive review about evolution of electric vehicles with emphasis on the information about 'Model', 'Make', 'Electric range', 'Base MRSP' and 'Electric Vehicle Type'. By using EV sales data the study focussed on global trends at the continent and country level by identifying the best and worst performing countries in terms of sales. Using data-driven methods, this study investigates the EV characteristics that have a significant influence on range. Web mining was used to get a comprehensive dataset of the technical parameters of commercial EV models produced between 2013 and 2023. Regression analysis of 103 EV models showed that price is significantly impacted by top speed and efficiency. Moreover, ML algorithms were trained and tested on a data set comprising (Historical, Projection-APS, and Projection-STEPS) for a time period of 2011-2030 with a lowest mean squared error of 0.00015 and r2 of 67 percent, and MSE 4.7 and r2 of 90 percent, obtained from Adaboost and XGB indicative of the good predictive accuracy of the model. These performance parameters that were determined are useful to EV consumers to choose best EV model.

Keywords: Electric vehicle, Energy consumption, Technology, ML algorithms, Regression.

INTRODUCTION

The landscape of electric mobility has changed significantly over the past ten years due to advancements in batteries and electric cars (EVs), as well as changes in charging infrastructure and the rising demand for renewable energy sources (Rubino *et al*., 2017; Barman *et al*., 2023). As a result, organizations are now more interested in streamlining and optimizing processes and goods, as well as reducing expenses in a developing sector. The purpose of the following paper is to identify the research that has been done on the development of the ecosystem for electric vehicles and the infrastructure that supports it, which makes it justified. This study is groundbreaking due to its longitudinal design, which sheds light on the evolution of research on electric vehicles and the infrastructure that supports them.

Government Regulations and Incentives: To increase the accessibility and appeal of EVs to customers, governments around the world have implemented a number of incentives, including tax breaks, grants, and subsidies. Automakers have also been under pressure to expand their selection of low emission automobiles due to strict emissions requirements. For example, the European Union's stringent CO2 emissions regulations have prompted large automakers to spend heavily in EV technology, which has directly contributed to the rise in EV sales.

Technology Developments has been largely attributed to advancements in battery technology. The range of EVs has increased and their cost has decreased due to the development of lithium ion batteries with higher energy densities and lower prices, making them a competitive choice for a wider spectrum of consumers. For instance, as EV adoption has increased over the past ten years, the average cost of lithium-ion batteries per kilowatt-hour has dropped dramatically.

Customers are becoming more conscious of and concerned about environmental issues, which has raised demand for sustainable substitutes. As people want to lessen their carbon footprint, EV sales are increasing, reflecting a shift in consumer preferences. Due to reduced long-term ownership costs and environmental concerns, surveys show that people are increasingly choosing EVs as their primary or secondary vehicles.

The rise of the EV market has also been aided by the increase of charging infrastructure. Range anxiety has decreased as a result of public and private expenditures in charging stations, making EVs a more sensible option for daily use. In cities, where a higher

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density of chargers has sped up EV adoption, there is a clear association between the availability of charging infrastructure and EV adoption rates. The automobile sector, energy markets, and international initiatives to lower greenhouse gas emissions are all significantly impacted by the EV market's explosive expansion. It promises less reliance on fossil fuels and lower emissions, signaling a significant move towards an electrified future.

Summary of the Main Contributions of Related Research Papers in the Literature

Author	The primary contribution of the study that is mentioned in the bibliography	The article's relationship to earlier publications in the bibliography
Adedeji (2023)	It suggests a novel model that precisely calculates important variables including CO2 emissions, battery recharge times, and fuel usage in cities, highways, and combined. This model is notable for being 29.1 times more accurate than conventional models, which makes it easier to create PHEV fuel efficiency labels that are more accurate.	By adding dummy functions to ANN, it enhances earlier models and boosts simulation accuracy. By incorporating several characteristics at once into simulations as opposed to separate models that only address one PHEV feature, it builds on earlier work. It enhances earlier studies on electric and hybrid vehicles' energy efficiency and emissions reduction.
Abdullah *et al*. (2024).	By 2050, HFCVs can cut yearly GHG emissions by as much as 67.09 percent in an ambitious scenario. The predicted demand for hydrogen is highest in China and India, with Germany and Japan also expressing a strong interest. Although there are infrastructure and financial obstacles, the switch to HFCVs is doable under supportive government plans.	By addressing global consequences and detailed forecasts for different HFCV penetration scenarios, it builds on earlier research. By contrasting vehicle technology and providing a thorough focus on the integration of HFCVs into international vehicle fleets, it enhances research It points out gaps in the body of research on the technical and financial viability of switching to HFCVs in developing nations.
Annamalai *et al*. (2023)	It offers a thorough examination of both isolated and non-isolated converters, covering cutting-edge topologies such bidirectional technologies and LLC resonance-switched converters. It suggests enhancements to fast charging techniques that maximize effectiveness and power quality while integrating renewable energy sources and power infrastructures.	By describing the benefits and drawbacks of various converter topologies, it expands on previous work. It draws attention to earlier studies on predictive controllers and their effects on energy efficiency, which support earlier research on developments in lithium batteries and charging infrastructure.
Bukola *et al*. (2025).	In order to help manufacturers optimize the design and operation of PHEVs, the article suggests an enhanced predictive model that increases the accuracy of PHEV energy consumption estimation. It emphasizes how supervised learning algorithms can cut down on the expenses and time needed to create new models.	The study builds on other studies that have examined predictive models in electric vehicles, including Ahmad *et al*. (2017) and Liu *et al*. (2022). This paper, however, varies in that it optimizes the energy performance of PHEVs by combining many supervised learning techniques into a single framework.
Das *et al*. (2024)	EVs release 70% less CO_2 than diesel vehicles and up to 97% less than gasoline-powered vehicles. The study emphasizes the significance of new battery technologies and clean energy sources. It highlights the difficulties associated with rare material shortages and the requirement to enhance battery recycling.	Through the integration of several life cycle phases—production, usage, and recycling—the study builds on earlier research on vehicle life cycle assessment. It contains a comparison of the energy and emissions used by conventional and electric automobiles.
Pennington *et al*. (2024).	The study proves that by lowering air pollution, the switch to electric vehicles improves public health generally. It highlights the necessity to look into the implications of this transformation for environmental justice as well as the dearth of observational research measuring the true impact globally.	By combining various data and findings about health and electric vehicles, this review builds on earlier research by emphasizing the advantages and drawbacks of this shift. This study offers a more comprehensive perspective by incorporating many viewpoints and geographical regions, whereas other comparable studies have concentrated more on certain aspects like emissions or financial advantages.
Soares *et al*. (2024).	It offers a thorough economic study demonstrating how much cheaper EV running costs are. in contrast to traditional automobiles. It offers a plan for removing obstacles to adoption in Brazil, including as infrastructure, laws, and public knowledge of dual-fuel and biofuel systems.	It supports research that examines the effects of EVs on the economy and environment while concentrating on the unique circumstances of the Brazilian market. It builds on earlier research on biofuel use by incorporating dual fuel systems and energy transition strategies. It highlights how current infrastructure might be modified to support the adoption of EVs by connecting global trends to regional specificities.
Gal´ an *et al*. (2023).	The study pinpoints the essential elements that propel multi-stakeholder partnerships (MSPs) for long-term growth in the EV industry. It offers a conceptual framework that emphasizes the necessity of collaboration, confidence, and dedication amongst partners in order to get over obstacles when putting charging infrastructure into place.	By specifically including sustainability and the connection of strategic objectives with SDGs, it broadens the corpus of research on MSPs. It blends theoretical stances such as transaction costs, institutional legitimacy, and shared resource theory.

Halder *et al*. (2024).	The study emphasizes how hydrogen fuel cell electric vehicles (HFCEVs) drastically lower greenhouse gas emissions and energy usage in contrast to conventional automobiles. It highlights both technological and financial obstacles, like the high cost of producing hydrogen and the scarcity of refueling infrastructure.	By examining topics that haven't been thoroughly examined, like energy management techniques and entire life cycle economic and emissions consequences, it builds on earlier research. It suggests future research directions and points out gaps in the literature around the commercialization of HFCEVs.
Holler *et al*. (2024)	The study emphasizes that ethanol-powered hybrid cars provide a workable short-term way to lessen Brazil's carbon footprint. Despite the fact that electric vehicles (EVs) cut pollutants by 85%, their expensive cost prevents widespread use. Flex fuel hybrid cars that run on ethanol cut emissions by 76% and are a more practical and affordable choice.	The study places its conclusions in the context of other research comparing vehicle technologies across geographical boundaries. It concludes that while EVs are cleaner, hybrids are more practical given the infrastructural and pricing situation in Brazil. It supports studies that examine trade-offs between costs and emissions.
Togun *et al*. (2024).	The study emphasizes how direct liquid cooling works well as a reliable method of controlling temperature of the battery and preventing thermal breakdown. It offers a thorough framework of developments in battery thermal management, addressing technical issues and suggesting ideas for the future, including using machine learning to control temperature.	By assessing less common cooling techniques including phase change materials (PCM) and direct liquid cooling, it enhances earlier research. It closes a gap in earlier research that primarily concentrated on traditional cooling techniques by introducing an examination of developing technologies.
Wazeer *et al*. (2023).	The study provides a thorough examination of the uses of composite materials in EVs, emphasizing how these components lighten vehicles and increase fuel economy. It talks about the prospects and obstacles facing the automotive industry's adoption of composite materials in the future.	It incorporates current market data and manufacturing technology advancements to update earlier research on lightweight materials, notably that conducted by Kumar *et al*. (2020). By incorporating fresh viewpoints on sustainability, it enhances research on composite materials like polymer reinforcements and aluminum alloys.
Zhang *et al*. (2025)	Especially when traveling for work, BEVs and PHEVs log more daily kilometers traveled (VKT) than ICEVs and HEVs. Neither a significant rebound impact linked to BEVs nor PHEVs has been demonstrated. When compared to privately owned vehicles, company or leased vehicles exhibit higher daily VKT, suggesting that ownership status has a greater influence on usage patterns than motorization type.	The study supports earlier research showing the impact of car ownership and battery range on user behavior. It fills gaps in the literature by extending research by differentiating between work and non-work uses, and it supports studies on range anxiety and low operating costs as factors influencing the use of electric vehicles.
Zhou *et al*. (2023).	The study suggests a model that increases the prediction accuracy of intricate and non-linear data, particularly for the French market and global sales of electric vehicles.	It increases the application of grey models by resolving issues with uncertainty and data distortion that hindered the efficacy of earlier methods.

METHODOLOGY

A systematic literature review (SLR), a methodical, exacting, and repeatable process for compiling, evaluating, and synthesizing the body of knowledge on a particular subject or research question, has been carried out. This investigation was conducted using the SLR technique in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. The study uses machine learning techniques to evaluate the impact and effectiveness of EVs. The information was obtained from a number of international databases for the reference period, which spans 1997–2011, 2011-2023, and its projection until 2035.

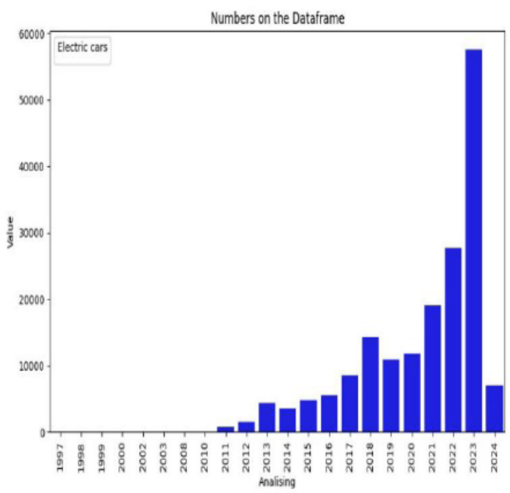


Figure 1: Electric Cars Industry Growth.

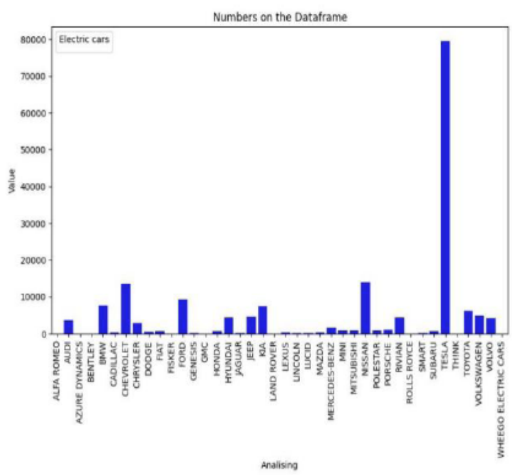


Figure 2: Number of Cars Produced by each company.

RESULTS AND DISCUSSION

Over the last 10 years EVs have remarkably undergone magnificent changes that are impelled by technological breakthroughs, ecological problems, and affirmative government plan of action. This growth is poised to continue as the automotive industry shifts towards sustainable and efficient transportation solutions. The growth of electric vehicles is a testament to the automotive industry's shift towards sustainable transportation. The study attempts to provide an analysis about the evolution of the electric car industry from 1997 - 2024.The study uses the visualization processes to match some information of the Data frame, in order to create graphics, visualizing this data matches and getting insights about it.

From 1997 to 2011 the electric cars have some researches and some companies produces some. What I can say that there was on a false research and test. From 2012 to 2022 there was significant growth, where the companies advanced on their research, tests and found a good solution for electric car. The marketplace starts to accept this models. 2023 (the outlier): As the Figure **1** shows, last year was a big year for the electric cars, where the companies had really good investments on it and, apparently, where the people starts to really understand that electric cars are good for the planet. "More than 8 million deaths were caused by air pollution in 2023, report shows An analysis also indicated that more than 5 million of these deaths are attributable to air pollution caused by the use of fossil fuels." Another point about the growth of electric cars can be related to the rapid growth of solar energy along the past few years, now that most of the people can have access to produce their on energy, becomes more vantageble for some people to have an electric car. From Figure **2** it is irrefutable that TESLA is the number one company in the electric cars field. It was interesting to note that Tesla recorded highest EVs sales with 1.8 million in 2023, a 38 % year-on-year gain. Over all for the year 2023, the auto maker sold-out over 3 million vehicles including 1.4 million plug-in hybrid models.

There are two different electric vehicle types, Battery Electric Vehicle (BEV) and Plug-in Hybrid Electric Vehicle (PHEV) (Figure **3**). In this Dataframe it can be observed that most part of produced cars are full electric, it was expected because TESLA is an outlier compared to the other companies and it only produces full electric cars. The biggest problem about electric cars, if you are a person that likes car travels, the longest range that a electric car can go is ranged from 0 to 350 kilometers autonomy in his battery full charged. A normal car, non electric powered, has an autonomy ranged from 400 to 600 kilometers, comparing this to a electric car is almost 40% more efficient than an electric car, in this point. Here I am are referring about the best cars in the market, but running all the Data frame the mean value of electric range is approximately 59 kilometers, that is even worse (Figure **4**). Because of that the companies enter in a choice of putting more technology on the batteries, that will increase significantly the 'Base MRSP' of the car, or make a bigger car to put a bigger battery on it, but it will still demands more power to move this car. In both situations the car will not get a range like non electric powered vehicles. But, if you stop to think for a second, what was the last time you traveled 300 kilometers by car? Another good thing to pay attention to, is that the 4 models that have the longest range are all from TESLA. A strange thing can be observed if comparing with the previous visualization, the model that have the longest electric range is 'MODEL S', but the most produced car was the 'MODEL Y'. MODEL S: Costs $66,490 (Tesla website), range 337 (Dataframe) MODEL Y: Costs $31,490 (Tesla website), range 291 (Dataframe)

Matching some information about the two models it can be seen that the value difference is to high, comparing to the range difference, of course that this is not only the point that makes the 'MODEL S' to have a high value difference from the 'MODEL Y' comfort, technology and performance are another big difference that has to be considered when pricing a car, but for someone that doesn't want to take all this investment,

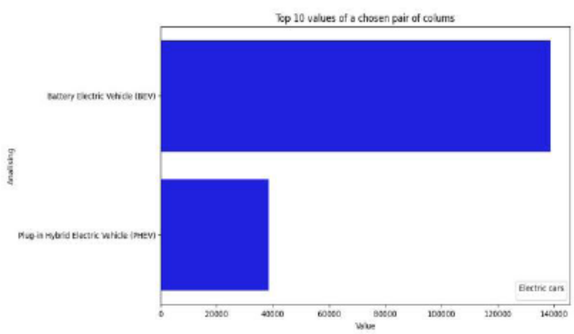


Figure 3: Most Produced Electric Vehicle Type.

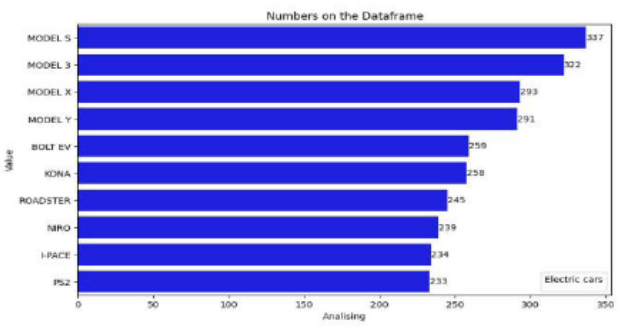


Figure 4: Electric range.

Table1: Descriptive Statistics

	Accel Sec	Top Speed	Range	Efficiency	Seats	Price Euro
mean	7.4	179.2	338.8	189.2	4.9	55813
std	3.02	43.6	126.01	29.6	0.79	34134.7
min	2.10	123	95	104	2	20129
25%	5.10	150	250	168	5	34429.5
50%	7.30	160	340	180	5	45000
75%	9.00	200	400	203	5	65000
max	22.40	410	970	273	7	215000

the MODEL Y attends his necessities and is lower than 50% of the price (Figure **5**).

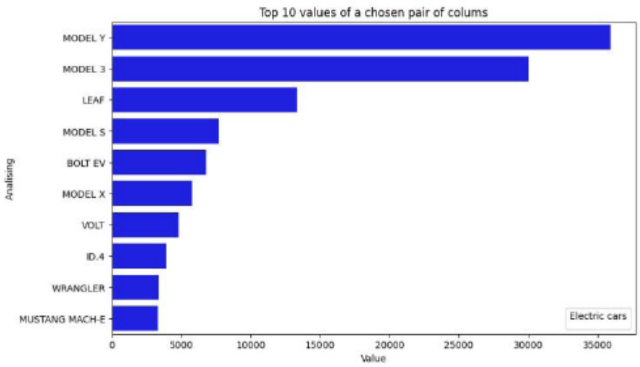


Figure 5: Model Produced.

The Figure's **8**, **9**, **10**, **11** and **12** display various characteristics technical features of varied models of EV. Byton, Fiat and smart are the prominent brands and Polestar being the least. The models Porsche, Lucid and Tesla produce the fastest cars and Smart the lowest. The Lucid, Light-year and Tesla have the highest range and Smart the lowest. By ton, Jaguar and Audi are considered as the most efficient and Light-year the least. Mercedes, Tesla and Nissan have the highest number of seats and Smart the lowest.

Most companies use Type 2 CCS and Type 1 ChadeMo the least and most cars are either SUV or Hatchback and C or B type with majority of cars that have 5 seats.

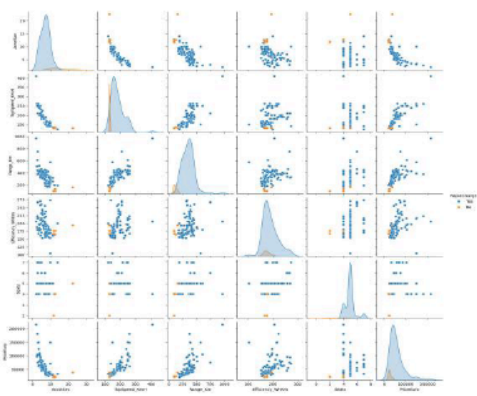


Figure 6: Pair plot of Rapid Charger presence.

Figure 7: Correlation Heat Map.

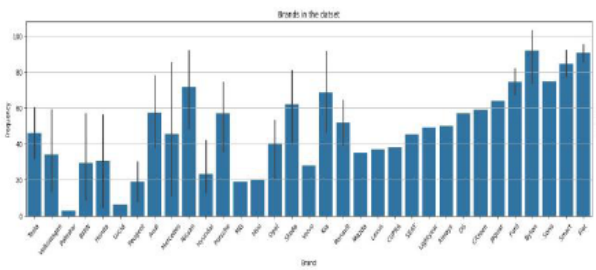


Figure 8: Frequency of Brands.

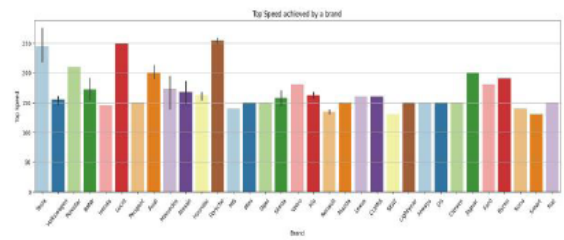


Figure 9: Top speeds achieved by cars of brands.

Only Top Speed and Efficiency are the two variables related to price. The study has analyzed the trends in EV market for the year 2025 and it is remarkable to note that more than 20% of new cars sold worldwide were electric.

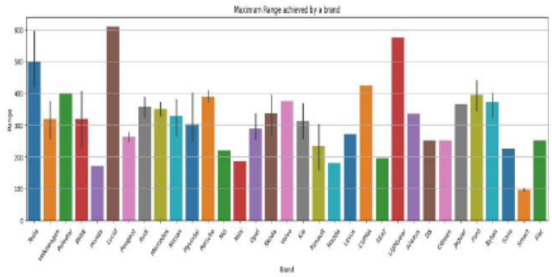


Figure 10: Range.

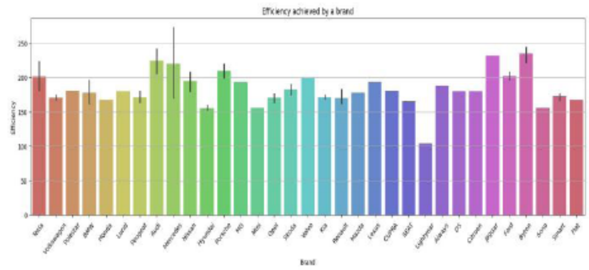


Figure 11: Efficiency.

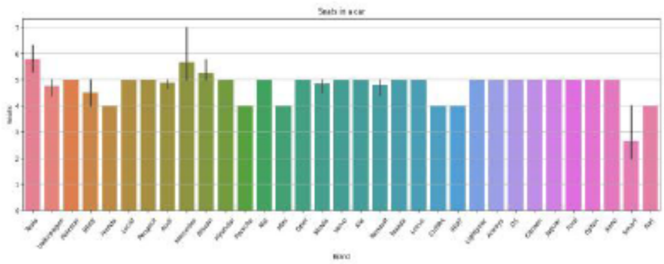


Figure 12: No: of seats.

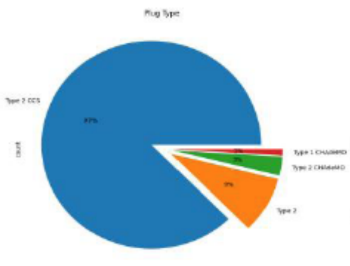


Figure 13: Plug.

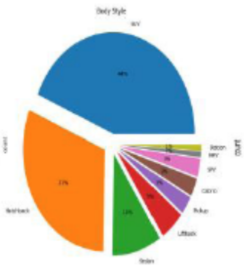


Figure 14: Body Style.

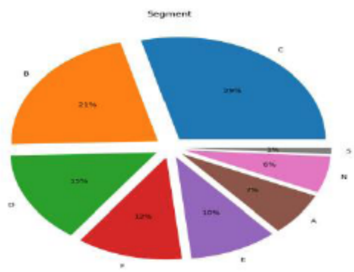


Figure 15: Segment.

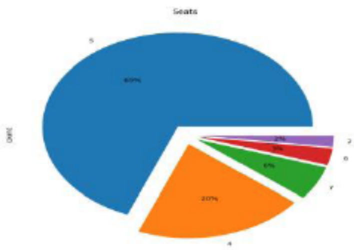


Figure 16: Seats.

Table 2: OLS Regression Results

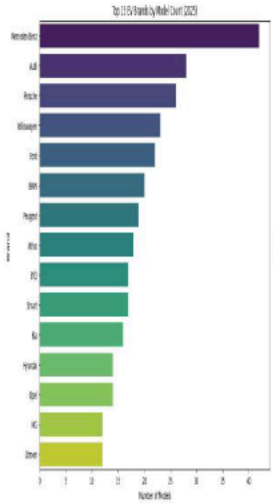
Dep. Variable:	Price Euro	**R-squared:**	0.711
Model:	OLS	**Adj. R-squared:**	0.699
Method:	Least Squares	**F-statistic:**	60.28
Date:	Fri, 05 Sept 2025	**Prob (F-statistic):**	1.37e-25
Time:	15:10:56	**Log-Likelihood:**	-1156.8
No. Observations:	103	**AIC:**	2324.
Df Residuals:	98	**BIC:**	2337.
Df Model:	4		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>ltl**	**[0.025**	**0.975]**
const	-1.051e+05	2.3e+04	-4.578	0.000	-1.51e+05	-5.96e+04
Accel Sec	1482.2127	1033.219	1.435	0.155	-568.178	3532.603
Range_Km	37.7714	22.680	1.665	0.099	-7.236	82.779
Top Speed_KmH	613.9243	78.224	7.848	0.000	458.691	769.157
Efficiency_WhKm	143.7166	68.228	2.106	0.038	8.320	279.113

Omnibus:	94.859	**Durbin-Watson:**	2.071
Prob (Omnibus):	0.000	**Jarque-Bera (JB):**	1049.593
Skew:	2.978	**Prob (JB):**	1.21e-228
Kurtosis:	17.460	**Cond. No.**	5.53e+03

Notes: [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

[2] The condition number is large, 5.53e+03. This might indicate that there are strong multicollinearity or other numerical problems.



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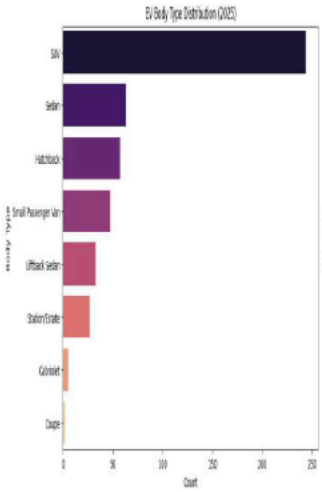

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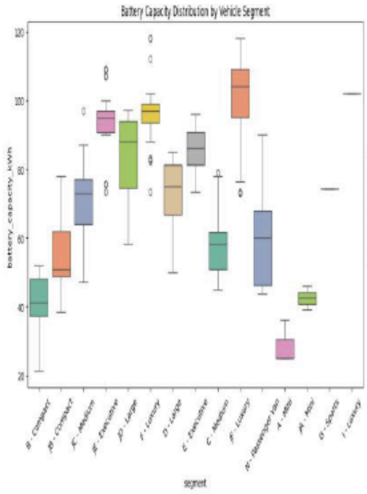

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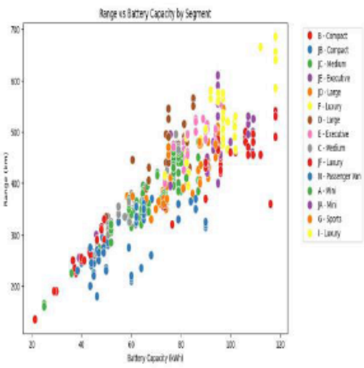

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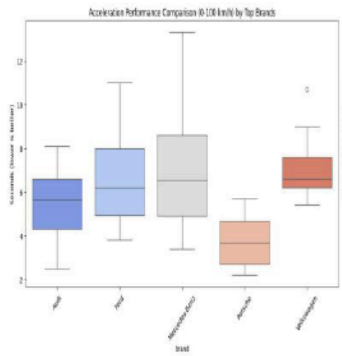

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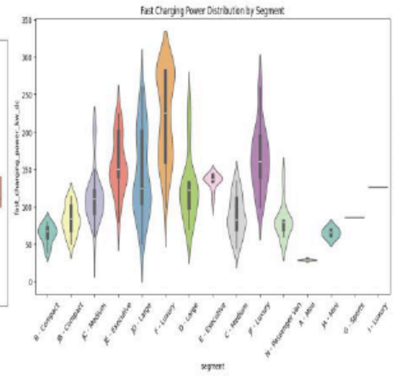

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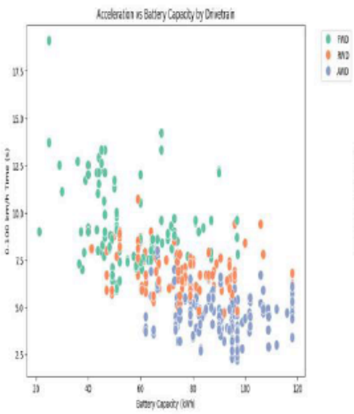

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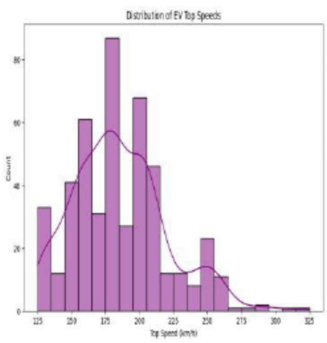

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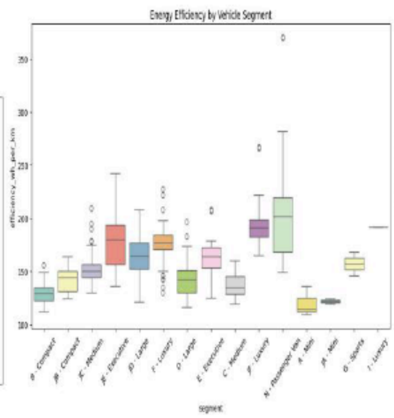
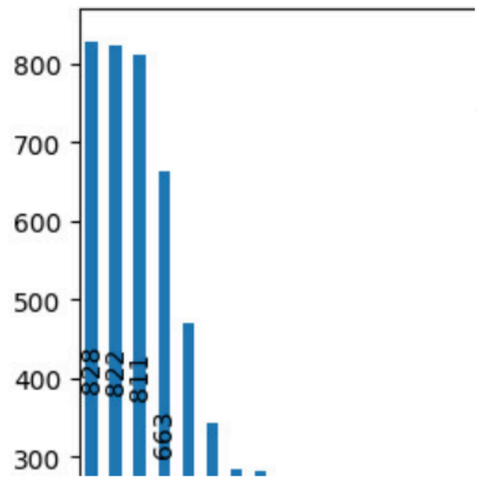


Figure 25

The research study emphasized the numerical sales count of EVs across globe during the time period 2011 to 2023 with a forecast up to 2035. The graphical illustrations of these are depicted to get an overview of popular categories by category", "parameter", "mode", "powertrain", "unit.



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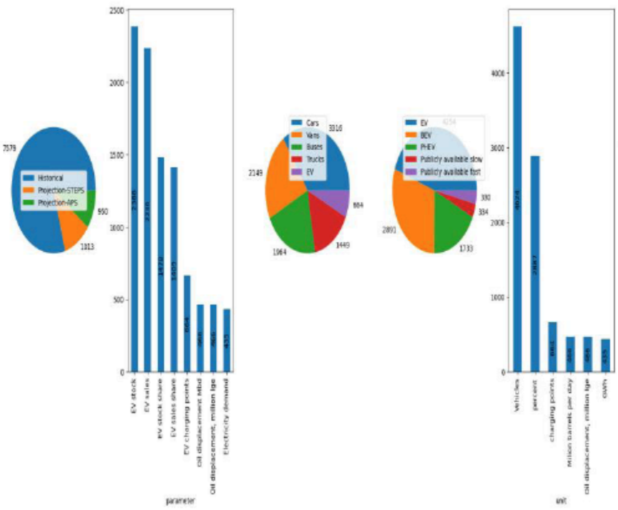

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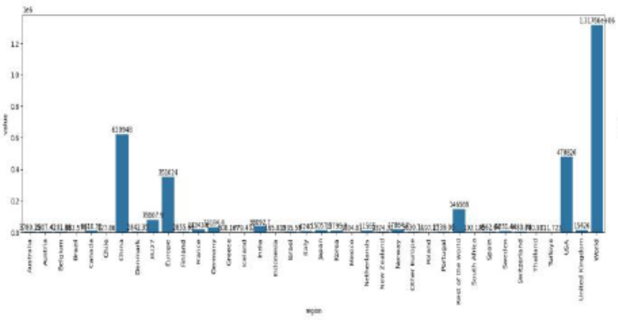

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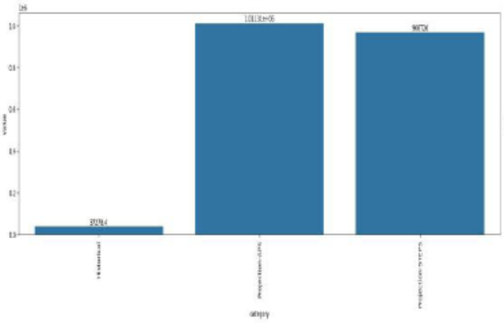

Figure 29:

The global increase in electric cars (EVs) is causing a major transition in the automotive sector toward sustainability. With an emphasis on global trends at the continent and national levels, this study attempts to examine EV sales statistics. The analysis entails determining which nations have the highest and lowest sales, illustrating these trends with a variety of chart formats, and using Folium to map EV sales geographically. The study seeks to provide answers to the following important questions through this analysis: Which continents and nations have the highest sales of EVs? How can the regional and temporal trends in sales be seen and interpreted? What conclusions can we draw regarding how EV adoption is distributed in various geographical areas? To give a thorough picture of the EV market in various geographical areas, the findings will be displayed via bar charts, pie charts, line charts, and interactive maps. The data set includes 12,654 rows and 7 columns, each of which represents EV sales and stock share information for different areas, broken out by year, vehicle type, and power train (*e.g.*, BEV, PHEV) over the 2011–2035 timeframe. The dataset contains the following columns: category: Is the data "Projected" or "Historical"? In order to properly assess the sales and stock of automobiles across various locations, the study focuses on the electric vehicle (EV) data set. The data collection is first filtered to only contain entries with the unit of measurement classified as "Vehicles." By doing this step, we can focus our study on pertinent facts. A summary of the information, comprising the number of vehicles, year, unit, powertrain type, mode (cars, buses, vans, and trucks), category, parameter, and region. We have 6,842 entries, according to the form of the filtered data set, which gives us a sizable amount of data for our research. Additionally, the research study learns more about the numerical components of the data set specifically, the year and value columns by employing the describe() technique. Here are some important figures. The mean value of the data, which covers the years 2010and2035, is 2019.88.Value (number of vehicles): The range of values is 0.001 at the lowest and 440,000,000 at the highest. Approximately 750,380 vehicles have been recorded on average. The standard deviation, which is roughly 9,307,153, shows a considerable degree of fluctuation in the number of cars.

The different levels of EV adoption and stock across different parts and vehicle types are reflected in these findings. Added to this, the research emphasizes on the data that ushers gainful insights about sales trends

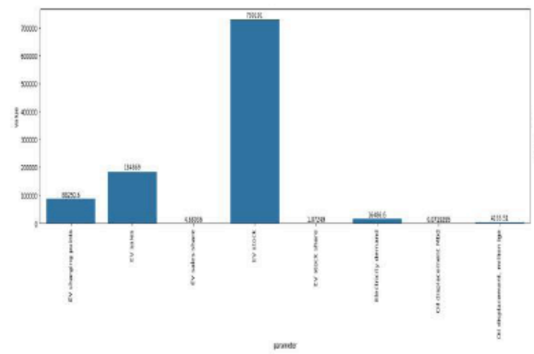

Figure 30:

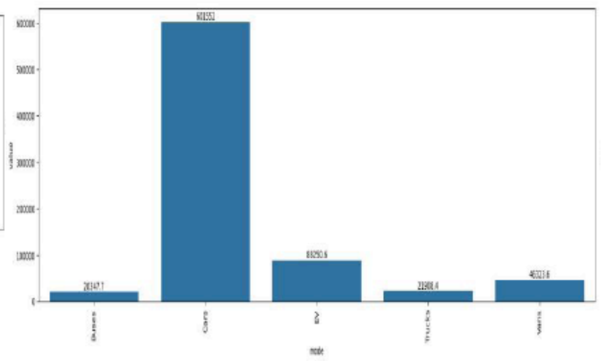

Figure 31:

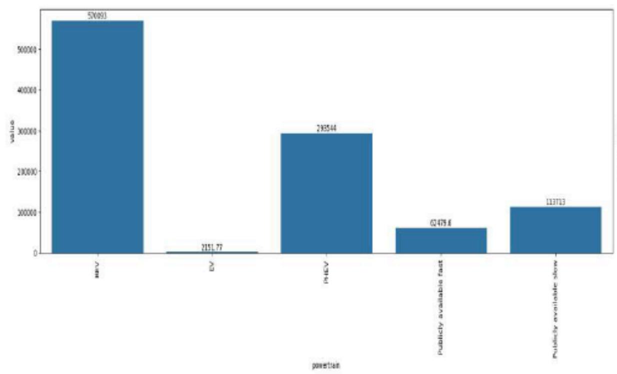

Figure 32:

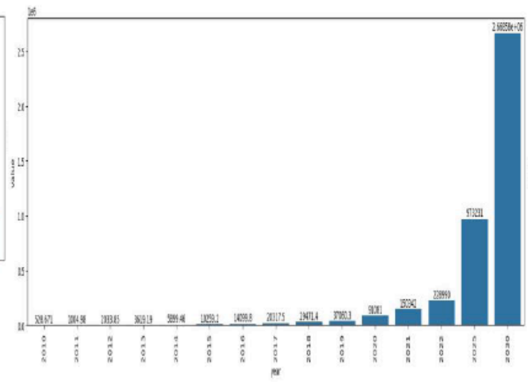

Figure 33:

over a period of years. The results of the Distribution of Electric Vehicle Modes exhibit the following breakdown: These include Cars: 2,975 records; Buses: 1,485 records; Vans: 1,449 records and Trucks: 933 records.

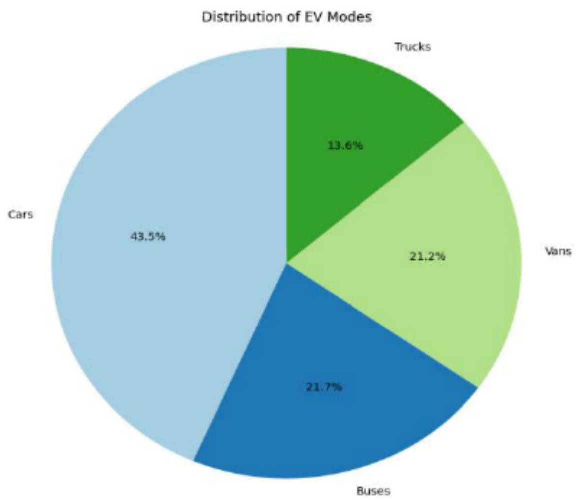

Figure 34:

The study further explored EV data set that contains minimum and maximum values that gives insights into the range of EV sales and stock figures.

Index	6151	12609
Region	Israel	World
Category	Historical	Projection -APS
Parameter	EV sales	EV Stock
mode	Buses	Cars
powertrain	BEV	BEV
year	2013	2035
unit	Vehicles	Vehicles
value	0.001	440000000.0

The maximum value is a projection for the total global EV stock of cars in 2035, with an estimated 440 million BEVs. This row represents future projections based on certain policy scenarios. These values highlight the vast range in the dataset, from minimal EV bus sales in a single country to global projections for a massive BEV car stock in the future. Seaborn is used to construct a line plot that shows the total number of vehicles sold or stocked in various regions. The y axis, which is presented on a logarithmic scale for easier management of wide ranging values, indicates the overall number of vehicles, while the x axis represents different regions. The log scale makes it easier to see regions with much higher totals, such as the USA or China.

Together, the line and bar charts provide a comprehensive view of the worldwide statistical

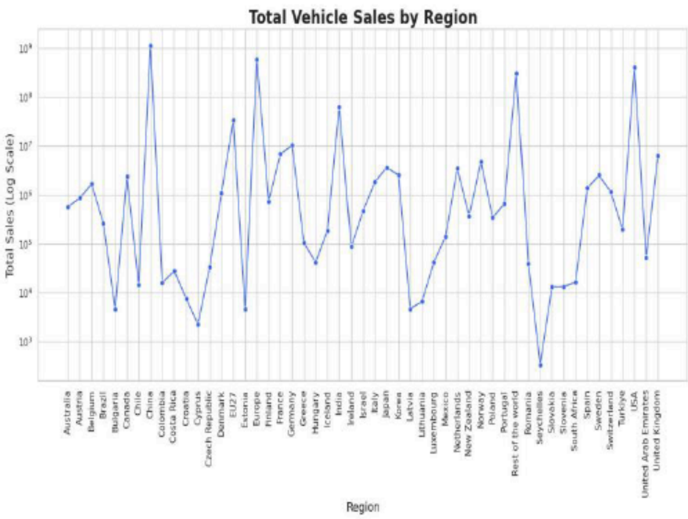

Figure 35:

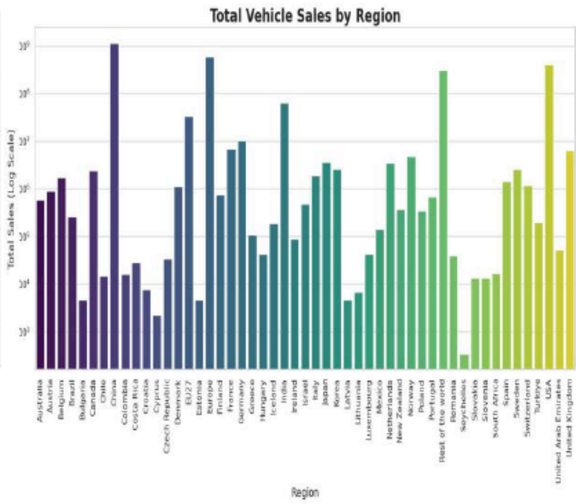

Figure 36:

distribution of total sales of electric vehicles (EVs) in various geographical areas. Both charts highlight the differences in EV adoption and market size across nations and regions, which is a remarkable modality in the global perspective of clean transportation. A logarithmic scale is used in the line chart to show the vast variation in EV sales, from smaller markets to world leaders. With the largest overall sales, China, the United States, the rest of the world, and Europe are undoubtedly driving the transition to electric vehicles. While allowing smaller regions like Seychelles, Cyprus, and Bulgaria to remain visible, the logarithmic scale effectively captures these significant disparities, showing their increasing, but still tiny, contributions to the global EV industry.

By clearly comparing the total number of vehicles sold in each region in descending order, the bar chart, on the other hand, enhances the line chart. This graphic makes it simple to identify smaller but developing markets like Brazil, Mexico, and Colombia while highlighting the dominance of regions like China, the USA, and Europe. A more direct comparison between regions is provided by the bar chart, which graphically depicts the notable difference between the leading and lagging markets. When combined, these two maps provide a comprehensive picture of global EV sales, showing that while some regions are progressively joining the electric mobility revolution, others, like China and Europe, are leading the way due to their robust infrastructure and governmental policies.

Line Chart on Countries Selling the Most EVs The line chart provides a clear visualization of the leading countries and regions in terms of electric vehicle (EV) sales. China stands out prominently, with over 1.14 billion EV sales, far surpassing other regions and cementing its position as the global leader in EV adoption. This dominance is driven by strong governmental incentives, large-scale production, and widespread infrastructure development. Following China, Europe and the USA occupy the next two leading positions, with sales totaling 593.78 million and 411.28 million, respectively. Europe's collective sales underscore the region's commitment to sustainability, with many countries actively pursuing climate goals and adopting green transportation policies. The USA, as another significant player, continues to expand its

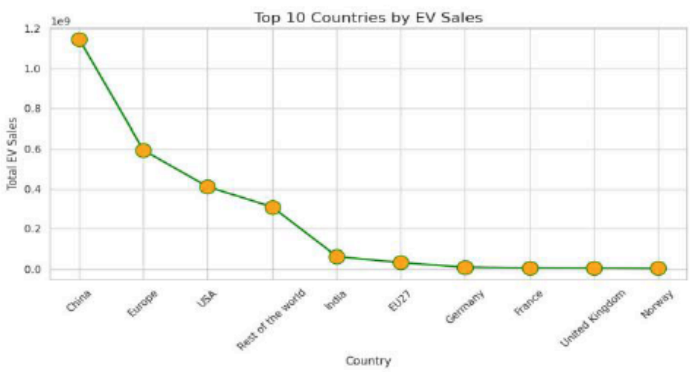

Figure 37:

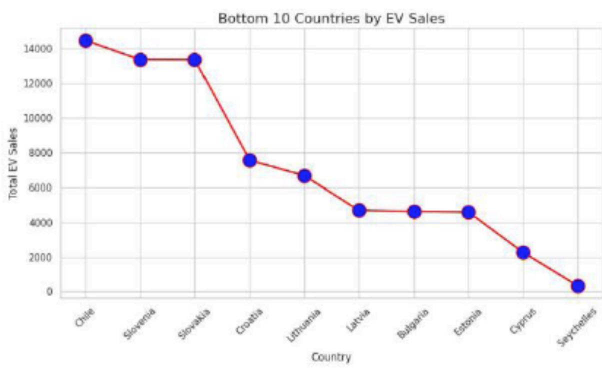

Figure 38:

EV market through a combination of innovation, increased consumer demand, and environmental policy shifts.

Regions like the Rest of the world and India follow; reflecting growing but less mature markets, where EV adoption is on the rise as infrastructure develops and electric mobility becomes more accessible. India, in particular, shows strong growth potential, with 63.4 million EV sales, driven by increasing environmental awareness and government initiatives aimed at reducing pollution. At the country level within Europe, Germany, France, and the United Kingdom lead EV adoption, with Germany standing out at over 10 million sales. Germany's position reflects its robust automotive industry and leadership in green technology. Norway also deserves attention, with 4.79 million EV sales, making it a global leader in EV sales per capita, thanks to strong government incentives and a highly eco-conscious population. This chart illustrates how different regions contribute to the global EV market, with China, Europe, and the USA clearly driving the electric vehicle revolution, while other markets, like India and various European countries, are showing significant progress.

Line Chart of the Nations with the Lowest EV Sales. Regions where EV adoption is still in its infancy are shown in the line chart that lists the nations with the lowest EV sales. These nations typically have smaller markets, fewer incentives, or infrastructure issues that prevent EVs from being widely used. With just 338 EVs sold, Seychelles has the lowest EV sales on the list. Being a small island nation, its EV adoption rates are greatly impacted by its small population and market size. With 2,260 EV sales, Cyprus comes in second, illustrating how slowly electric mobility is being adopted in smaller, less populated European regions.

Going a little higher, nations with sales under 7,000 units, such as Estonia, Bulgaria, Latvia, and Lithuania, show slower adoption than more established European countries. This is probably because they have less extensive EV infrastructure and fewer government incentives. Slovenia (13,363), Slovakia (13,351), and Croatia (7,557 sales) all make modest strides toward EV adoption, although they remain lag behind more populous European nations. Even though they are EU members, these countries are still building the laws and infrastructure required to grow their EV markets.

With 14,458 EV sales, Chile is the only non European nation on this list, demonstrating the fledgling development of electric mobility in South America. Building a complete EV network is difficult in Chile, like in other emerging economies, however there are encouraging signs of progress. This graph highlights the global gap in EV sales, showing that some areas are rapidly adopting EVs while others are only beginning the shift to electric mobility.

Comparing the Top 5 and Bottom 5 Countries in EV Sales using a Line Chart. The line graph illustrates the substantial global variance in EV adoption by contrasting the sharp decline in EV sales between the top 5 and bottom 5 nations. With more than 1.1 billion EV sales, China is by far the best performer and has established itself as the global leader in the electric vehicle market. China is leading the world in EV adoption because to its large population, robust government support, and quick infrastructure construction. Due to strict environmental laws and the extensive availability of charging stations in nations like Germany, Norway, and France, Europe comes in second with around 594 million sales. With over 411 million sales, the US comes in third place, demonstrating the nation's increasing trend toward electric mobility and the leadership of states like California in EV promotion. With more than 308 million sales, the rest of the world category encompasses a number of smaller markets worldwide, demonstrating that the EV movement is gaining traction even outside

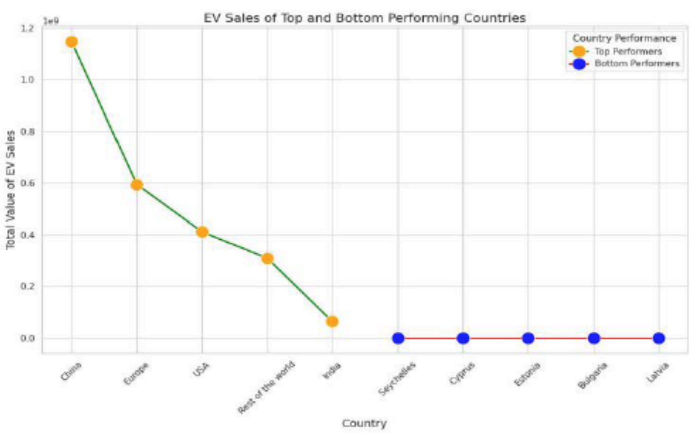

Figure 39:

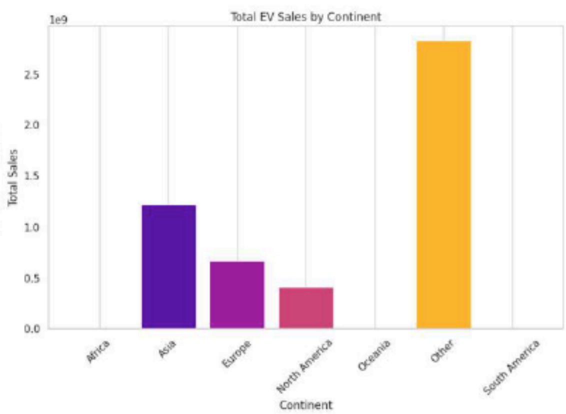

Figure 40:

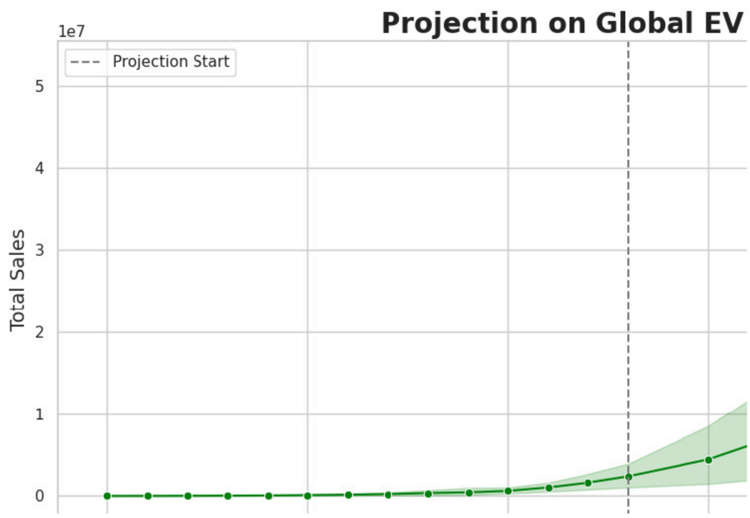

Figure 41:

of the top regions. Finally, although it's still lagging behind the leaders, India's about 63 million EV purchases show the nation's growing interest in electrification. The story of the bottom five nations, however, is rather different. At the extreme end of the range, Seychelles has only sold 338 EVs, illustrating the difficulties smaller island governments have implementing new technologies. With 2,260 sales, Cyprus comes in second, demonstrating a sluggish adoption of EVs, probably as a result of a smaller market and limited infrastructure. The slower rate of EV adoption in smaller European nations is further demonstrated by the fact that Estonia, Bulgaria, and Latvia each have fewer than 5,000 sales. While the leading countries are racing toward a future dominated by electric mobility, others are still in the early phases of adoption. This sharp discrepancy between the top and bottom 5 countries demonstrates the global inequality in EV sales. The graph highlights the necessity of customized strategies to promote EV expansion in underperforming areas. Sorting by Continent Using a dictionary (continent_map), each country or region is manually assigned to its corresponding continent (*e.g.*, Australia to Oceania, China to Asia) in order to generate a continent mapping that will aid in future analysis. The vehicles_countries_df data frame is then updated with this map, adding a new 'continent' column that links each nation to its corresponding continent. The code then sums the total EV sales (total_value) for each continent after grouping by continent using the group by () function. The continent_totals data frame has this aggregated data, with the column names changed to total_sales and continent to make the data more understandable. The total EV sales for each continent are displayed in the final result, continent_totals. Asia has more than 1.2 billion sales, followed by North America (413 million) and Europe (671 million). While the 'Other' category accounts for 308 million sales worldwide, smaller regions such as Oceania and South America display relatively modest totals.

The global EV (Electric Vehicle) sales forecast from 2010 to 2035 is shown in this line graph. The y-axis displays the overall number of EV sales, and the x-axis shows the years. Over time, EV sales show a consistent upward trend, with a sharp uptick beginning in 2023, as indicated by the vertical dashed line. As we approach farther into the future, the shaded area surrounding the line shows uncertainty and offers a visual representation of the possible variation in future estimates. We can clearly see from this graphic how EV sales are predicted to rise globally, particularly after 2023.

CONCLUSION AND DISCUSSION

Even while the market for electric vehicles is expanding, not all vehicle types and consumer preferences are now represented in the selection, especially when it comes to larger vehicles like trucks and SUVs. Industry Solution: To accommodate a wider variety of vehicle types, automakers are quickly growing their EV lines. To satisfy the wide range of consumer needs, new SUVs, electric trucks, and even performance cars are being released. Companies working together are also creating shared platforms and technologies, which facilitate the production of a greater range of electric vehicles. The study looked at how EV sales are expected to be distributed globally across various continents. We were able to identify important patterns in EV adoption, particularly in Asia, Europe, and North America, by displaying the data using a variety of charts and maps. EV sales are expected to rise sharply after 2023, according to forecasts based on a special focus on the "World" data.

Asia is the region with the most EV sales, followed by North America and Europe, demonstrating the widespread use of EVs in these areas. According to predictions, there will be a large increase in global EV sales, particularly after 2023.We were able to identify areas with high and low adoption by using mapping techniques and heat maps to effectively illustrate the geographic distribution of EV sales. Unexpectedly high sales in the "Other" category suggest possible data aggregation from several locations or unknown markets.

CONFLICTS OF INTEREST

The author declared no conflicts of interest.

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