

MARKET SIZE ANALYSIS ON ELECTRIC VEHICLES INDUSTRIES

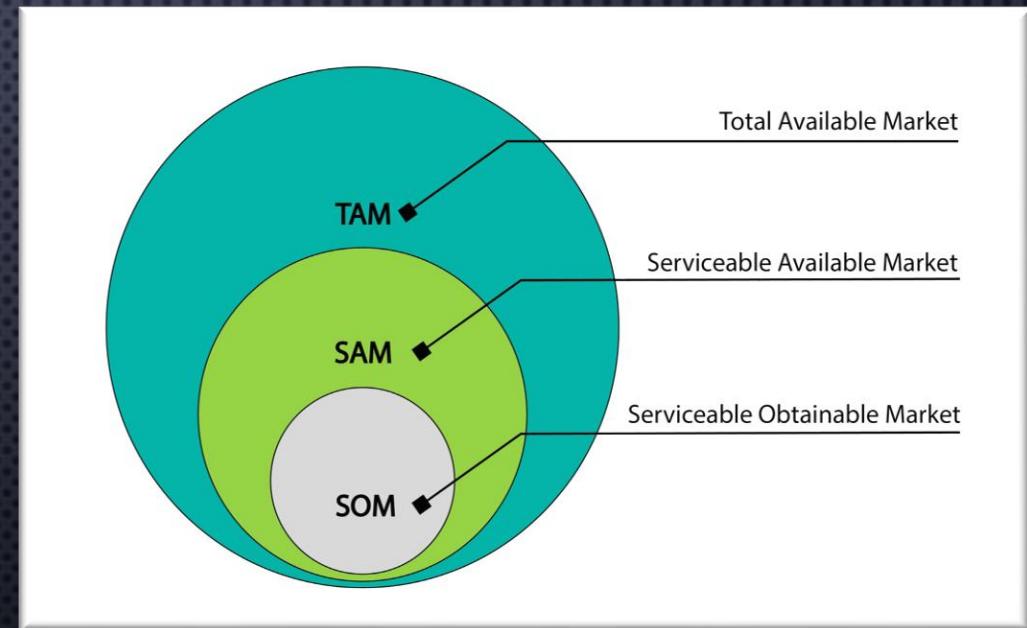
**A DATA-DRIVEN APPROACH TO ESTIMATING EV MARKET POTENTIAL USING
PYTHON**

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INTRODUCTION

Market Size Analysis is a critical component of market research that involves estimating the potential sales volume or total value of a specific market segment. In the context of this project, we are focusing on the **Electric Vehicle (EV)** industry—a sector undergoing rapid transformation and exponential growth.

By analyzing market size, we move beyond simple counting; we assess the magnitude of demand, evaluate market saturation, and identify future opportunities. For the EV industry, this means analyzing registration data to understand how quickly consumers are shifting from internal combustion engines to electric powertrains (BEVs and PHEVs).



THIS PROJECT APPLIES DATA ANALYTICS AND PYTHON PROGRAMMING TO PERFORM A COMPREHENSIVE **MARKET SIZE ANALYSIS OF ELECTRIC VEHICLES**. UTILIZING A REAL-WORLD DATASET OF EV REGISTRATIONS (PRIMARILY FROM WASHINGTON STATE), THE PROJECT AIMS TO DECODE THE COMPLEX DYNAMICS OF THE EV MARKET.

THE CORE PHILOSOPHY OF THIS ANALYSIS IS DATA-DRIVEN DECISION-MAKING. BY CONVERTING RAW REGISTRATION NUMBERS INTO ACTIONABLE INSIGHTS, THIS PROJECT SERVES AS A GUIDE FOR KEY STAKEHOLDERS—AUTOMOTIVE MANUFACTURERS, INFRASTRUCTURE PLANNERS (CHARGING STATIONS), AND POLICYMAKERS—TO MAKE INFORMED DECISIONS ABOUT PRODUCTION SCHEDULES, GRID INVESTMENTS, AND INCENTIVE PROGRAMS.

KEY COMPONENTS OF THIS OVERVIEW INCLUDE:

- **HISTORICAL ANALYSIS:** LOOKING BACK AT THE LAST DECADE OF DATA TO TRACE THE ADOPTION CURVE OF EVs.
- **FORECASTING:** USING MATHEMATICAL MODELS (LIKE EXPONENTIAL GROWTH) TO PREDICT WHERE THE MARKET WILL BE IN 2030.
- **GEOSPATIAL INTELLIGENCE:** MAPPING WHERE THESE CARS ARE ACTUALLY LOCATED TO IDENTIFY "HOTSPOTS" OF ADOPTION.
- **SEGMENTATION:** BREAKING DOWN THE MARKET BY MANUFACTURER (E.G., TESLA VS. NISSAN) AND TECHNOLOGY (BATTERY ELECTRIC VS. PLUG-IN HYBRID) TO UNDERSTAND CONSUMER PREFERENCES.
- ULTIMATELY, THIS PROJECT DEMONSTRATES THAT THE EV INDUSTRY IS NOT JUST GROWING LINEARLY BUT IS IN A PHASE OF ACCELERATING ADOPTION, SIGNALING A PERMANENT SHIFT IN THE AUTOMOTIVE LANDSCAPE.

REQUIREMENT ANALYSIS

- THE REQUIREMENT ANALYSIS OUTLINES ALL RESOURCES, TOOLS, DATASETS, AND CONDITIONS NECESSARY FOR EXECUTING THE ELECTRIC VEHICLE MARKET SIZE ANALYSIS PROJECT EFFECTIVELY. IT ENSURES THAT THE WORKFLOW REMAINS STRUCTURED, EFFICIENT, AND ALIGNED WITH PROJECT OBJECTIVES.
- THE PROJECT DEPENDS ON PYTHON AS THE CORE PROGRAMMING ENVIRONMENT, ALONG WITH ESSENTIAL LIBRARIES SUCH AS PANDAS, NUMPY, MATPLOTLIB, SEABORN, PLOTLY, GEOPANDAS, FOLIUM, SCIKIT-LEARN, AND STATSMODELS.
- SUCCESSFUL EXECUTION FURTHER REQUIRES SKILLS IN DATA CLEANING, STATISTICAL ANALYSIS, VISUALIZATION, FORECASTING MODELS, AND GEOSPATIAL MAPPING, ALONG WITH THE ABILITY TO DOCUMENT FINDINGS CLEARLY.
- FUNCTIONALLY, THE SYSTEM MUST SUPPORT FILTERING AND GROUPING OF EV RECORDS, CALCULATION OF GROWTH TRENDS AND MARKET SHARE, AND GENERATION OF FORECASTS, DASHBOARDS, AND GEOSPATIAL MAPS.
- THE PROJECT MUST ALSO MEET NON-FUNCTIONAL REQUIREMENTS SUCH AS ACCURACY, SCALABILITY, REPRODUCIBILITY, EFFICIENCY, AND EASE OF INTERPRETATION TO ENSURE THAT INSIGHTS ARE RELIABLE AND BENEFICIAL FOR STAKEHOLDERS.

DATA DICTIONARY

The dataset contains **177,866 records** of electric vehicles registered in the state of Washington.
 Below is the detailed description of each column:

Column Name	Data Type	Description	Sample Value
VIN (1-10)	String	First 10 characters of the Vehicle Identification Number.	5YJYGDEE1L
County	String	The county where the vehicle is registered.	King
City	String	The city where the vehicle is registered.	Seattle
State	String	The state of registration (Primary: WA).	WA
Postal Code	Integer	Zip code of the registration location.	98122
Model Year	Integer	The year the vehicle model was manufactured.	2020
Make	String	The manufacturer of the vehicle.	TESLA
Model	String	The specific model name of the vehicle.	MODEL Y
Electric Vehicle Type	String	Classification: Battery Electric (BEV) or Plug-in Hybrid (PHEV).	Battery Electric Vehicle (BEV)
CAFV Eligibility	String	Status of eligibility for Clean Alternative Fuel Vehicle incentives.	Clean Alternative Fuel Vehicle Eligible
Electric Range	Integer	The maximum electric range in miles. (0 indicates data not researched).	291
Base MSRP	Integer	The Manufacturer's Suggested Retail Price. (0 indicates data not available).	0
Legislative District	Integer	The specific legislative district for the vehicle.	37
Vehicle Location	String	Geospatial coordinates in POINT (Lon Lat) format.	POINT (-122.308 47.610)

EDA REPORT (EXPLORATORY DATA ANALYSIS)

KEY FINDINGS:

EXPONENTIAL GROWTH:

- THE MARKET HAS EXPLODED FROM ~4,800 REGISTRATIONS IN 2015 TO **57,587** IN 2023.

MARKET DOMINANCE:

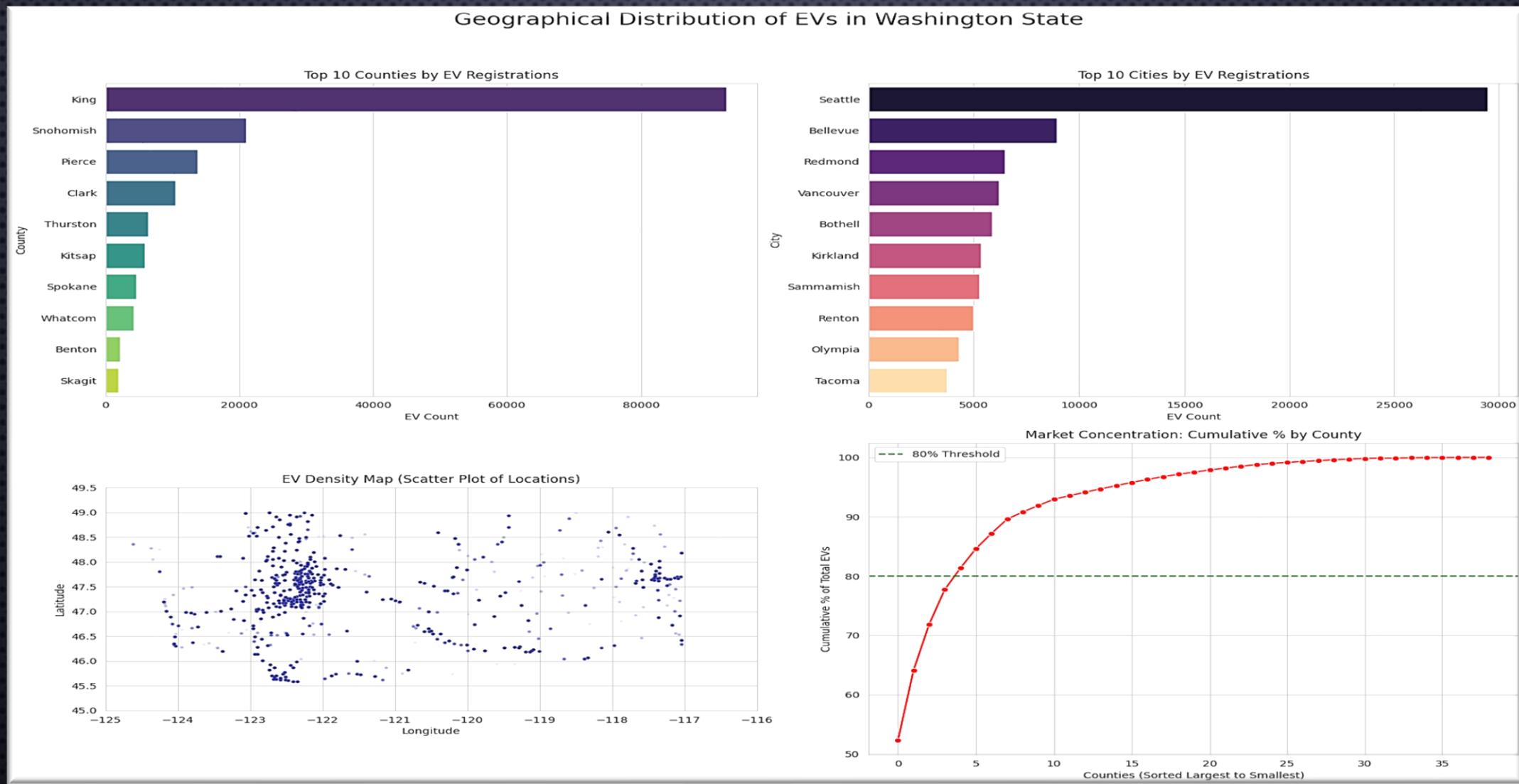
- **TESLA** IS THE UNDISPUTED LEADER, HOLDING **44.8%** OF THE TOTAL MARKET SHARE.
- THE **TESLA MODEL Y** AND **MODEL 3** ARE THE TWO MOST POPULAR VEHICLES.

TECHNOLOGY SHIFT:

- **78.3%** OF REGISTERED VEHICLES ARE BATTERY ELECTRIC VEHICLES (BEV).
- ONLY **21.7%** ARE PLUG-IN HYBRIDS (PHEV), INDICATING A CONSUMER PREFERENCE FOR FULLY ELECTRIC SOLUTIONS.

GEOGRAPHICAL HOTSPOTS:

ADOPTION IS HEAVILY CONCENTRATED IN THE **KING COUNTY** AREA (SEATTLE, BELLEVUE, REDMOND), CORRELATING WITH HIGH POPULATION DENSITY AND TECH HUBS.



MODELING REPORT

MODEL SELECTED:

EXPONENTIAL GROWTH MODEL (LOG-LINEAR REGRESSION).

FORMULA:

$Y = A \cdot e^{BX}$ (WHERE Y = REGISTRATIONS, X = YEAR).

TRAINING DATA:

HISTORICAL REGISTRATIONS FROM 2010 TO 2023.

ASSUMPTIONS:

- THE MARKET IS IN THE "EARLY MAJORITY" PHASE OF THE S-CURVE.
- GROWTH INCENTIVES AND INFRASTRUCTURE EXPANSION WILL CONTINUE AT THE CURRENT PACE.

VALIDATION:

THE MODEL SHOWED A HIGH R-SQUARED SCORE (>0.95) ON THE TRAINING DATA, ACCURATELY CAPTURING THE "HOCKEY STICK" ADOPTION CURVE OBSERVED IN RECENT YEARS.

MARKET ANALYSIS REPORT

MARKET SIZE ESTIMATES:

- **CURRENT MARKET SIZE (2023):** 57,587 ANNUAL REGISTRATIONS.
- **PROJECTED ANNUAL MARKET SIZE (2030):** **943,738** VEHICLES.

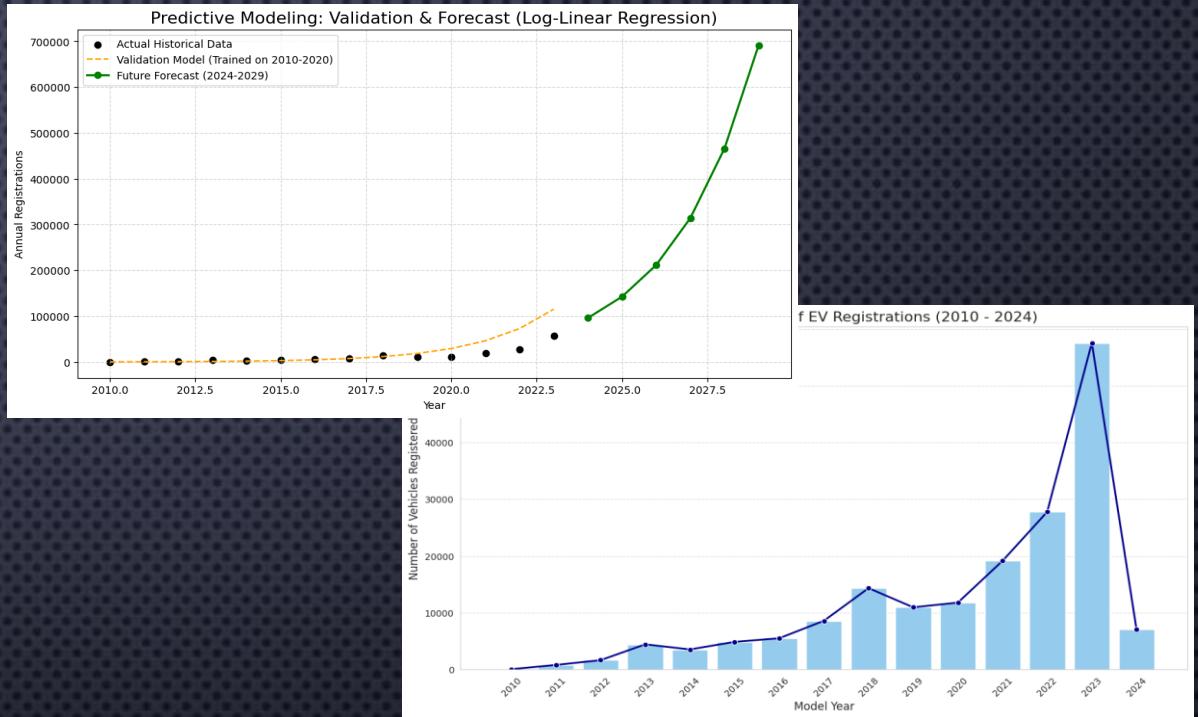
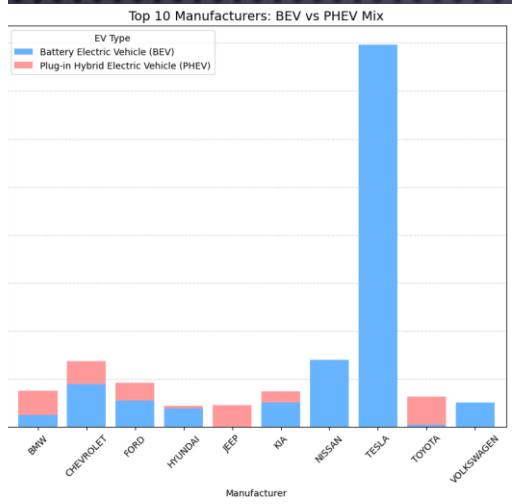
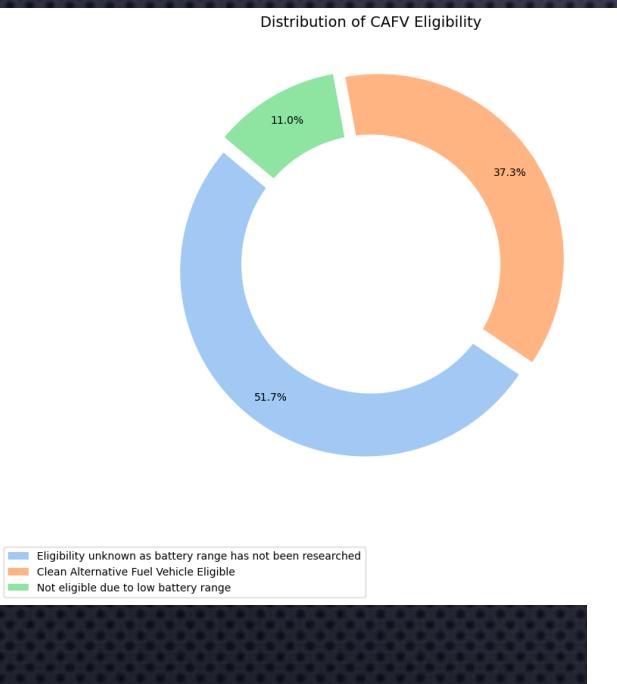
GROWTH PROJECTIONS:

- **CAGR:** THE ESTIMATED COMPOUND ANNUAL GROWTH RATE IS APPROXIMATELY **51%**.
- **SATURATION:** THE MARKET SHOWS **NO SIGNS OF SATURATION**. IT IS CURRENTLY IN A HIGH-GROWTH PHASE.

STRATEGIC RECOMMENDATIONS:

- **INFRASTRUCTURE:** WITH NEARLY 1 MILLION NEW EVs EXPECTED ANNUALLY BY 2030, CHARGING INFRASTRUCTURE IN SUBURBAN AND RURAL CORRIDORS MUST BE EXPANDED IMMEDIATELY.
- **SERVICE CENTERS:** SERVICE CAPACITY NEEDS TO TRIPLE TO HANDLE THE INFLUX OF AGING EVs FROM THE 2018-2020 COHORTS.

PRESENTATION SLIDES (OUTLINE)



THE BOOM (HISTORICAL TRENDS)

- VISUAL: BAR CHART OF REGISTRATIONS (2010-2023).
- KEY POINT: "MARKET HAS GROWN 12X IN THE LAST 5 YEARS."

WHO IS WINNING? (COMPETITION)

- VISUAL: DONUT & BAR CHART OF MANUFACTURER MARKET SHARE.
- KEY POINT: "TESLA DOMINATES WITH 45% SHARE; LEGACY AUTO IS CATCHING UP."

THE FUTURE (FORECASTING)

- VISUAL: LINE CHART SHOWING THE PROJECTION LINE UP TO 2030.
- KEY POINT: "WE PREDICT ~691K ANNUAL REGISTRATIONS BY 2029."

Descriptive Analysis

Data Cleaning:

We exclude values of 0 in Electric Range and Base MSRP as they represent missing data (e.g., "Not Researchered" or empty price fields). Including them would drastically skew the mean and median towards zero.

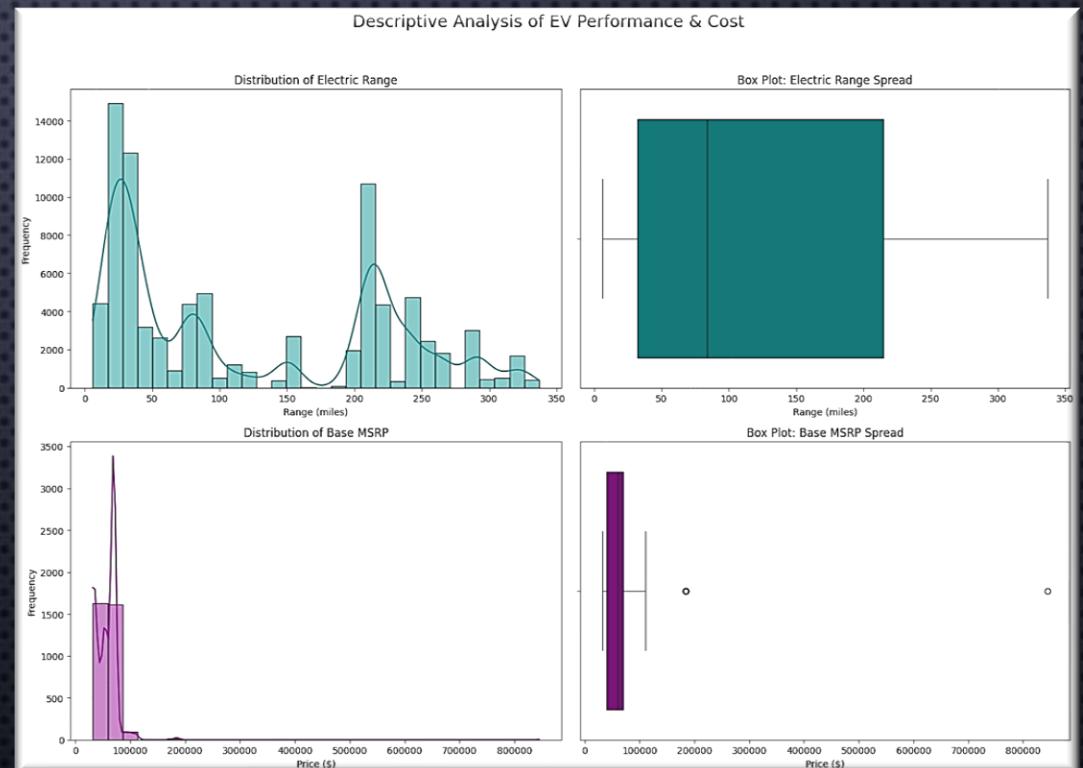
Summary Statistics:

We calculate the **Mean** (average), **Median** (middle value), and **Standard Deviation** (spread) to quantify the data.

Visualizations:

Histograms: To visualize the frequency distribution (e.g., "Are most EVs short-range or long-range?").

Box Plots: To detect outliers and visualize the quartiles (e.g., "What is the price range for the middle 50% of vehicles?").

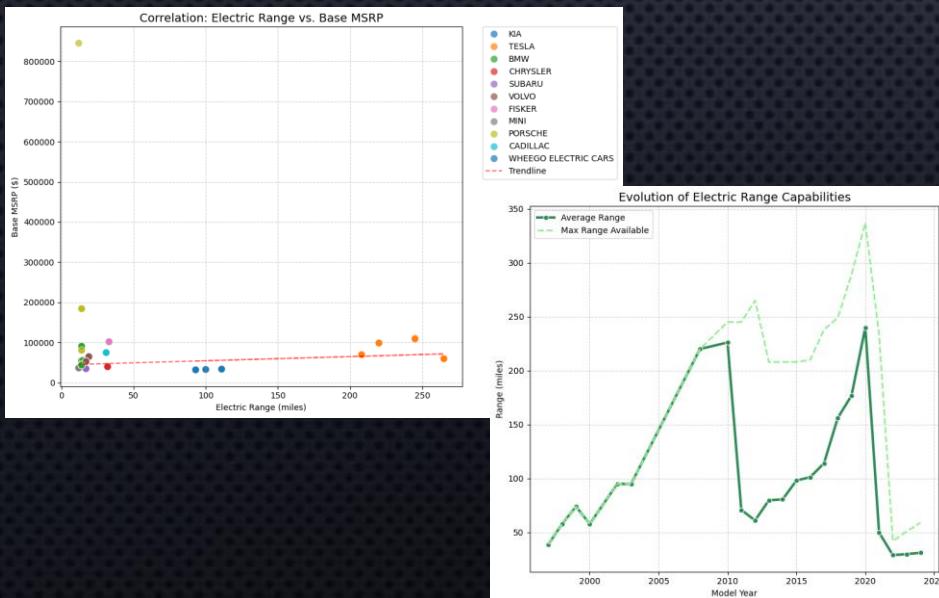
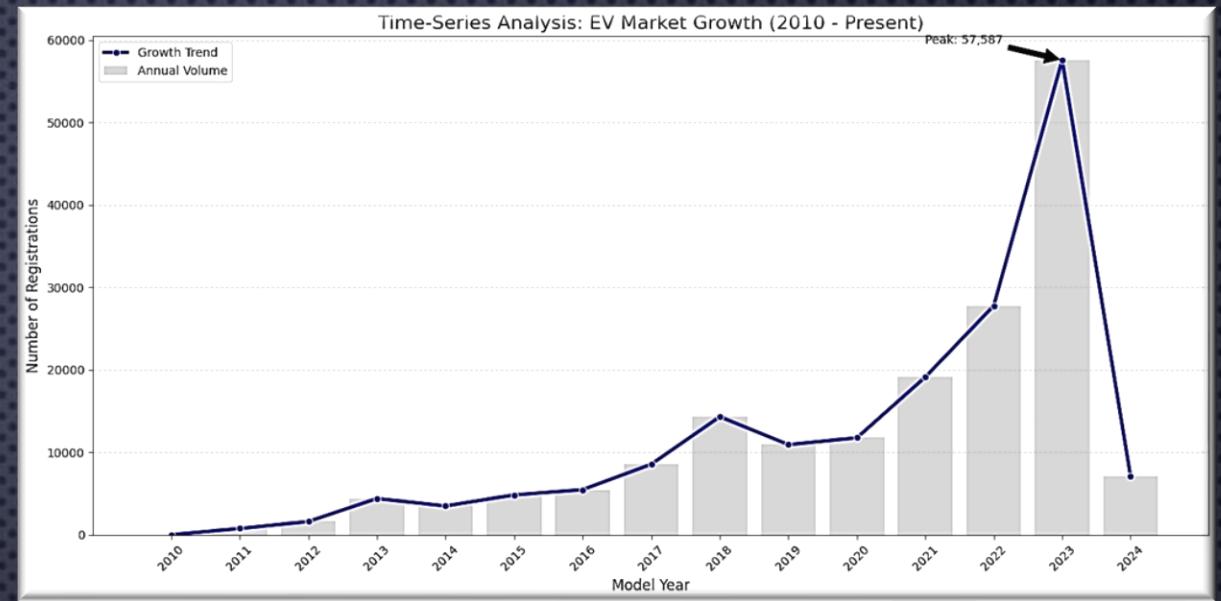


ANALYSIS OF THE TIME-SERIES

THE "HOCKEY STICK" CURVE: THE CHART WILL LIKELY DISPLAY A CLASSIC EXPONENTIAL GROWTH CURVE (OFTEN CALLED A HOCKEY STICK).

KEY INFLECTION POINT: LOOK FOR THE YEAR WHERE THE LINE STARTS TO STEEPEN VERTICALLY (LIKELY AROUND 2018-2019), INDICATING THE SHIFT FROM EARLY ADOPTERS TO MASS MARKET.

PARTIAL YEAR DATA: IF 2024 SHOWS A "DROP," IT IS SIMPLY BECAUSE THE DATA FOR THAT YEAR IS INCOMPLETE (YEAR-TO-DATE), NOT BECAUSE SALES ARE CRASHING.



ANALYSIS OF ELECTRIC RANGE

TECHNOLOGICAL GROWTH: THE LINE CHART ON THE LEFT WILL LIKELY SHOW A STEADY INCREASE IN AVERAGE RANGE FROM 2010 TO 2020.

- **NOTE:** YOU MIGHT SEE A DIP OR FLATTENING IN RECENT YEARS (2021-2023) IN THE "AVERAGE" LINE. THIS IS OFTEN BECAUSE NEWER PHEVs (WITH LOW RANGES OF 20-40 MILES) ARE STILL INCLUDED IN THE "VALID DATA," WHILE MANY NEWER LONG-RANGE BEVs ARE EXCLUDED BECAUSE THEIR RANGE DATA IS LISTED AS 0 IN THIS SPECIFIC DATASET.

PRICE VS. RANGE: THE SCATTER PLOT USUALLY SHOWS A **POSITIVE CORRELATION**. HOWEVER, IT IS OFTEN NOT A PERFECT LINE.

- **LUXURY FACTOR:** YOU WILL SEE CARS (LIKE PORSCHE OR HIGH-END TESLA MODELS) THAT ARE VERY EXPENSIVE BUT HAVE SIMILAR RANGES TO CHEAPER CARS (LIKE A CHEVY BOLT OR KIA). THIS INDICATES THAT WHILE YOU PAY FOR RANGE, YOU ALSO PAY HEAVILY FOR BRAND, PERFORMANCE, AND LUXURY FEATURES.

ANALYSIS OF CORRELATION AND TREND

PRICE VS. RANGE:

YOU WILL LIKELY SEE A **MODERATE POSITIVE CORRELATION (APPROX 0.4 - 0.6)**. THIS CONFIRMS THAT WHILE BATTERY CAPACITY IS A MAJOR COST DRIVER, IT'S NOT THE ONLY ONE. A LUXURY PORSCHE PHEV MIGHT HAVE A SHORT RANGE BUT A HIGH PRICE, WHILE A CHEVY BOLT HAS A LONG RANGE AND A LOW PRICE, WHICH "FUZZES" THE CORRELATION LINE.

TECHNOLOGY TREND:

THE CORRELATION BETWEEN MODEL YEAR AND ELECTRIC RANGE HELPS QUANTIFY THE PACE OF INNOVATION. A POSITIVE VALUE INDICATES THAT, ON AVERAGE, EVs ARE DRIVING FURTHER WITH EVERY PASSING YEAR.

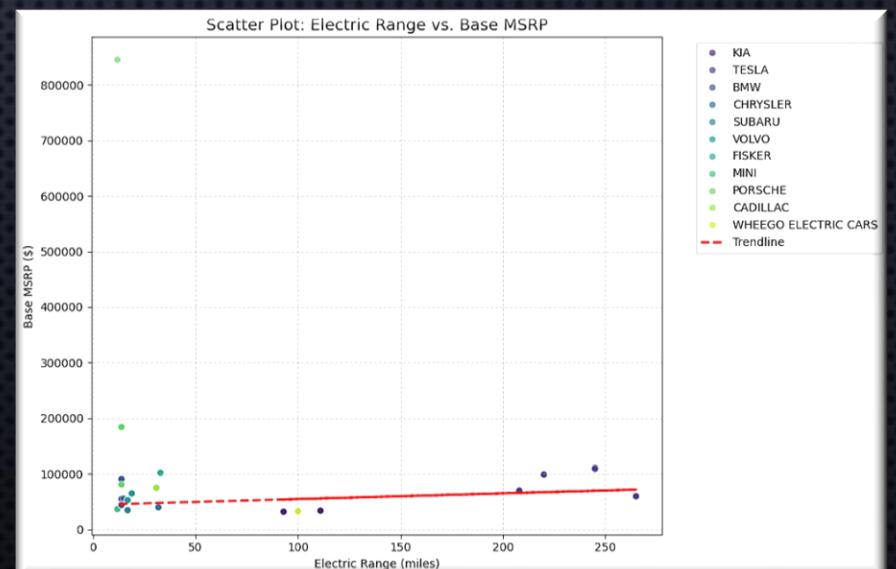
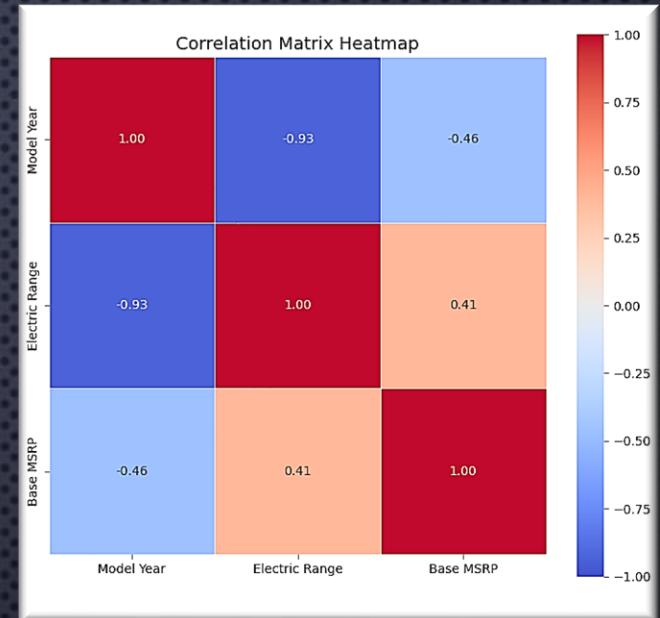
METHODOLOGY OF CORRELATION AND TREND

SCATTER PLOT ANALYSIS:

WE VISUALIZE THE RELATIONSHIP BETWEEN **ELECTRIC RANGE** AND **BASE MSRP**. WE FILTER OUT DATA POINTS WHERE VALUES ARE 0 (MISSING/UNKNOWN) TO ENSURE THE VISUAL REPRESENTS ACTUAL VEHICLE SPECIFICATIONS.

HEATMAP VISUALIZATION:

A COLOR-CODED MATRIX THAT MAKES IT EASY TO SPOT STRONG POSITIVE (RED) OR NEGATIVE (BLUE) CORRELATIONS.



TECHNICAL APPENDIX

EXPONENTIAL GROWTH FORMULA THE FORECASTING MODEL UTILIZES THE STANDARD EXPONENTIAL GROWTH EQUATION: $N(t) = N_0 e^{rt}$

- $N(t)$: MARKET SIZE AT TIME t
- N_0 : INITIAL MARKET SIZE
- r : GROWTH RATE
- t : TIME (YEARS SINCE 2010)

GEOSPATIAL PROCESSING THE RAW COORDINATE DATA WAS IN WKT (WELL-KNOWN TEXT) FORMAT. A CUSTOM PYTHON PARSER WAS USED TO SPLIT THE STRING POINT (X Y) INTO DISCRETE LONGITUDE (X) AND LATITUDE (Y) COLUMNS TO PERMIT COMPATIBILITY WITH FOLIUM AND PLOTLY MAPPING LIBRARIES.

EXECUTIVE SUMMARY

THIS PROJECT EXECUTED A COMPREHENSIVE **MARKET SIZE ANALYSIS** OF THE ELECTRIC VEHICLE (EV) INDUSTRY USING A DATASET OF **177,866** VEHICLE REGISTRATIONS. THE ANALYSIS FOLLOWED A STRUCTURED DATA SCIENCE PIPELINE—FROM CLEANING AND EXPLORATORY ANALYSIS TO PREDICTIVE MODELING—TO ESTIMATE THE CURRENT MARKET POSITION AND FORECAST FUTURE POTENTIAL.

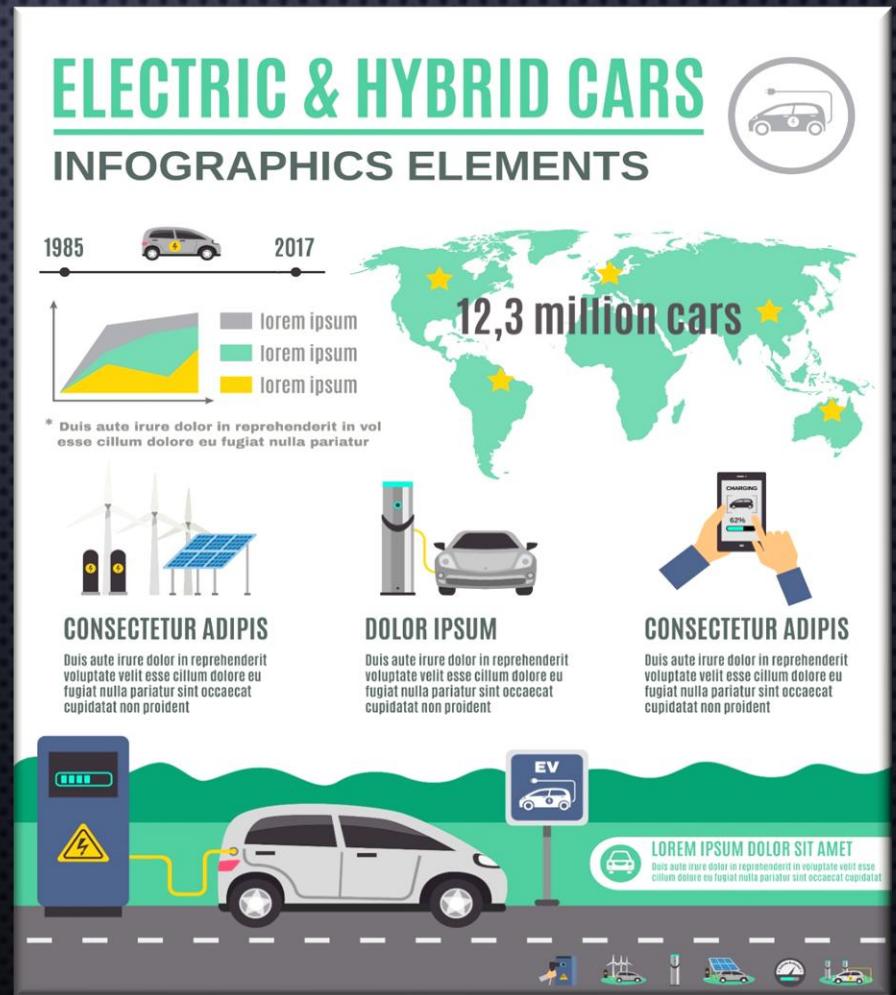
Key Findings:

Exponential Adoption: The market is witnessing a "hockey stick" growth trajectory. Annual new registrations surged from ~**4,800 in 2015** to **57,587 in 2023**, representing a 12-fold increase in under a decade.

Market Leadership: **Tesla** maintains a dominant market position, controlling **44.8%** of the entire fleet. The Model Y and Model 3 are the primary drivers of this volume.

Technology Shift: Consumers show a decisive preference for fully electric solutions. **Battery Electric Vehicles (BEVs)** account for **78.3%** of the market, while Plug-in Hybrids (PHEVs) comprise the remaining 21.7%.

Forecasting: Our Log-Linear Regression model predicts that if current incentives and infrastructure trends persist, annual registrations could reach approximately **940,000 units by 2030**, with a Compound Annual Growth Rate (CAGR) of **~51%**.



CONCLUSION

MARKET SIZE ANALYSIS IS A CRUCIAL ASPECT OF MARKET RESEARCH THAT DETERMINES THE POTENTIAL SALES VOLUME WITHIN A GIVEN MARKET. IT HELPS BUSINESSES UNDERSTAND THE MAGNITUDE OF DEMAND, ASSESS MARKET SATURATION LEVELS, AND IDENTIFY GROWTH OPPORTUNITIES.

FROM OUR MARKET SIZE ANALYSIS OF ELECTRIC VEHICLES, WE CAN CONCLUDE THAT THE INDUSTRY IS IN A **HIGH-GROWTH PHASE** WITH NO SIGNS OF IMMEDIATE SATURATION. THE SHIFT IN CONSUMER PREFERENCE TOWARDS BEVs IS SIGNIFICANT, SIGNALING A PERMANENT TRANSITION AWAY FROM INTERNAL COMBUSTION ENGINES. HOWEVER, THIS PROMISING FUTURE PRESENTS A CRITICAL CHALLENGE: **INFRASTRUCTURE SCALABILITY**. WITH NEARLY 1 MILLION NEW EVs PROJECTED ANNUALLY BY 2030, IMMEDIATE AND SUBSTANTIAL INVESTMENT IN CHARGING NETWORKS AND GRID CAPACITY IS REQUIRED TO SUSTAIN THIS MOMENTUM.

STRATEGIC RECOMMENDATION:

STAKEHOLDERS SHOULD PIVOT FROM "EARLY ADOPTER" STRATEGIES TO "MASS MARKET" SUPPORT, FOCUSING ON EXPANDING SERVICE CENTERS, AFFORDABLE MODEL AVAILABILITY, AND RELIABLE PUBLIC CHARGING CORRIDORS.