

Research Article

# Visualizing the Growth of Electric Vehicles (2010-2024) using Power BI: A Data-Driven Insight

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## ABSTRACT

The global shift toward electric vehicles (EVs) represents a critical strategy to reduce carbon emissions and achieve sustainability goals. Yet, adoption remains uneven across regions, driven by disparities in infrastructure, policy incentives, and consumer behavior. This study addresses the need for a clearer, data-driven understanding of EV adoption trends between 2010 and 2024 by leveraging interactive visual analytics in Power BI. Data were collected from publicly available global EV sales and stock statistics. Preprocessing involved standardizing region names, removing duplicates (reducing from 6,607 to 6,592 records), and enriching the dataset with drivetrain categories and time variables. Power BI dashboards were developed to present EV sales, stock levels, sales share, stock share, regional adoption patterns, drivetrain distribution, and temporal growth. Results revealed that Battery Electric Vehicles (BEVs) dominated sales at 1,078 units out of 3,798 total, with the highest adoption in the USA and the World region collectively accounting for over 60% of the share. Sales peaked in 2021 at 338 units, aligning with policy incentives and post-pandemic recovery. Line and bar charts demonstrated an accelerating adoption trend post-2020, while pie and donut charts highlighted disparities across regions and drivetrains. These interactive dashboards enable policymakers, industry leaders, and researchers to explore complex EV market dynamics, identify priority regions for infrastructure investment, and design targeted policy interventions. By making patterns in EV adoption more transparent and accessible, this approach supports data-driven planning toward sustainable transport transitions.

**Keywords:** Electric Vehicle Adoption; Data Visualization; Power BI; Sustainable Transport; Global Trends.

## 1. INTRODUCTION

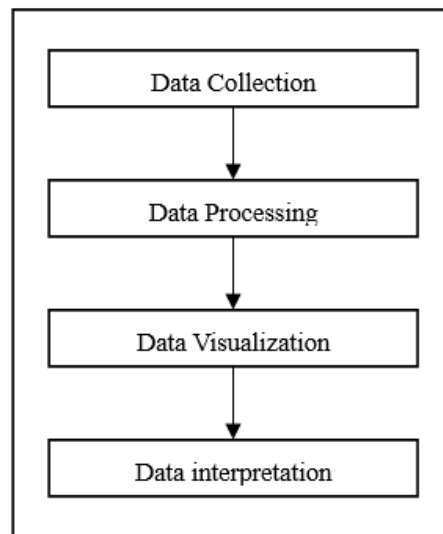
Over the last decade, the global automotive industry has undergone a transformative shift driven by the increasing adoption of Electric Vehicles (EVs). This transition is motivated by growing environmental awareness, stricter emissions regulations, and rapid technological advancements in battery systems (IEA, 2024). For example, EV sales reached 14 million units in 2023, accounting for 18% of all new car sales globally, with China contributing 60%, Europe 25%, and the United States 10%. However, this surge in adoption is highly uneven. Developing regions, such as Southeast Asia, continue to lag behind, with EV market shares under 5% in countries like Indonesia (Times of India, 2025). Challenges include high vehicle costs, limited charging infrastructure, and policy uncertainty (Khan et al., 2021). The World Bank and IEA note that these disparities threaten to widen global sustainability gaps if left unaddressed.

Previous studies have explored EV market trends using static charts or regional snapshots (Karmakar et al., 2021; Jung et al., 2023). Yet, there is a critical gap in research that integrates temporal patterns, regional disparities, and drivetrain variations into a single, interactive framework. As Singh et al. (2024) emphasize, achieving sustainability in mobility requires comprehensive analysis tools that reveal both global adoption patterns and local infrastructural readiness. This study addresses that gap by applying Power BI to create an interactive dashboard that visualizes EV adoption from 2010 to 2024 across dimensions of time, region, and drivetrain type. By enabling dynamic filtering and exploration, this research aims to support evidence-based policymaking, investment planning, and public awareness, especially in developing contexts where understanding barriers is crucial for equitable transition to sustainable transport.

## 2. RESEARCH METHOD

This research uses a descriptive quantitative approach with a systematic framework consisting of four main stages, namely data collection, data processing, data visualization, and data interpretation. This approach is considered ideal because it is

able to transform raw data into meaningful information through the help of interactive visualization. In line with this, Pevec, Babic, and Podobnik (2019) stated that "the massive growth of electric vehicle data demands effective tools to extract meaningful patterns and present them clearly to users.



**Figure 1.** Research Model Framework

The first step was data collection, which involved downloading the Electric Car Sales 2010-2024 dataset from the Kaggle website <https://www.kaggle.com/datasets/jainaru/electric-car-sales-2010-2024>. This dataset includes information on sales year, country, vehicle brand, number of units sold, and percentage of market share. Due to its open and comprehensive nature, this dataset is worth exploring in the context of global electric vehicle sales trends. The dataset is available in CSV format with a file size of 239.25 KB, containing 3,798 rows and 9 columns of data. The dataset is structured using a 5-star schema with 7 main data points including: 1) EV Dataset, 2) Powertrain, 3) Unit, 4), Year, 5) Parameter, 6) Region, 7) Measure Table. With Total: 1) 70 Measure Table, 2) 20 Column in Main Dataset, 3) 3 Column in every data on Parameter, Powertrain, Region, Unit, Year. The size of the uploaded Power BI file is about 459KB. This schema allows users to understand and analyze the data more effectively and standardized.

Next, the data was processed using the Power Query feature in Power BI. This stage includes data cleaning from empty and duplicate values, normalization of numerical and categorical data formats, and grouping by analysis dimensions such as year, country, and manufacturer. Saket, Endert, and Demiralp (2017) assert that "a clean and structured dataset is a critical component in producing visualizations that can be interpreted accurately and efficiently by users.

The third stage was data visualization using Power BI. Various types of visualizations were used, such as line charts for annual sales trends, bar charts to compare sales between countries and manufacturers, and pie charts and visual maps to display geographic distribution of market share. Visualizations are also equipped with visual cards that display important figures in a concise manner, such as total units sold or the country with the highest sales. In addition, slicers are embedded to allow users to interactively filter data by year, country or specific brands. As stated by Hüttel et al. (2021), "interactive visualization empowers users to explore insights independently and at their own pace, thus supporting decision-making in dynamic data environments."

The final stage is data interpretation. The visualization results were analyzed descriptively to identify patterns of sales spikes, contribution of each country, and dominance of certain manufacturers in the electric car market. The findings are then validated by comparing the results with official reports such as the Global EV Outlook from the International Energy Agency (IEA), to ensure that the trends match the actual conditions on the ground. Through this methodology, the research is expected to provide a robust and informative picture of the dynamics of electric vehicle growth globally.

### 3. RESULTS AND DISCUSSION

#### 3.1 Model View (Star-Schema)

The data model used in this study follows a star schema structure, which enhances data accessibility and analytical efficiency. At the core of this schema lies the fact table "Sales", which records the core quantitative data, namely the number of electric vehicle (EV) units sold. This fact table is connected to five dimension tables: Year, Country, Brand, Model, and Vehicle Type.

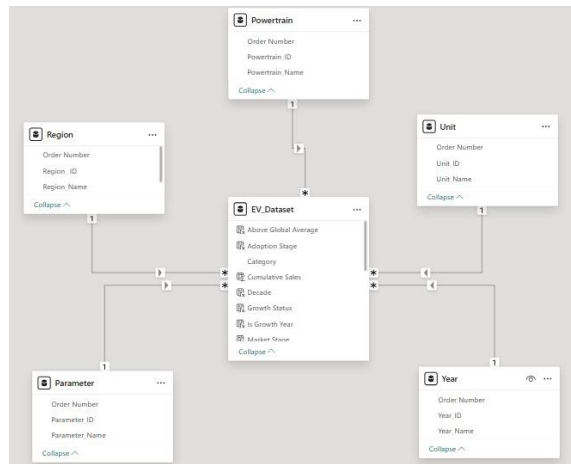


Figure 2 Star Schema Model View

This star schema design supports multidimensional analysis, The “Country” dimension facilitates geographical segmentation, allowing an analysis of electric vehicle adoption across different global regions. This dimension enables researchers to identify dominant markets such as China, the United States, and Germany, while also highlighting emerging potential in Southeast Asia-despite infrastructural and economic challenges. Meanwhile, the “Year” dimension allows temporal analysis of adoption trends, revealing key growth periods such as the significant surge in sales between 2020 and 2023.

Although the dataset does not include detailed attributes such as brand or vehicle type, the model still provides substantial analytical flexibility across countries and time periods. This allows users to uncover macro-level trends in EV adoption and correlate them with national policy developments, technological advancements, or economic factors influencing the broader electric vehicle market. Conceptually, measurement tables are not included in the logical data schema because they do not represent entities or have relationships between tables. However, in Power BI practice, this table is used as a container for organizing measures to improve the efficiency and readability of report models.

### 3.2 Interpretation of EV Statistic Dashboard Visualization

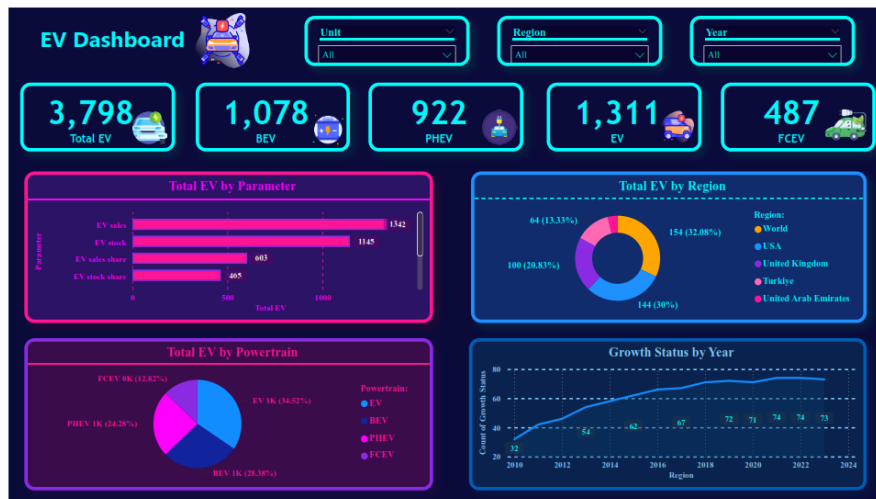


Figure 3 EV Statistic Dashboard

The EV Statistics Dashboard offers a holistic and structured overview of global electric vehicle (EV) adoption trends between 2010 and 2024. The summary cards reveal total EV sales of 3,798 units, with detailed segmentation across drivetrains: Battery Electric Vehicles (BEVs) at 1,078 units, Plug-in Hybrid Electric Vehicles (PHEVs) at 922 units, general EV categories at 1,311 units, and Fuel Cell Electric Vehicles (FCEVs) at 487 units. This distribution demonstrates the strong market preference for BEVs, supported by declining battery costs and policy incentives (Vision Research Reports, 2024). The bar chart displaying sales, stock, sales share, and stock share—valued at 1,342, 1,145, 603, and 405 respectively—highlights the critical balance between supply and demand. This insight is crucial for stakeholders planning production and charging infrastructure, supporting observations by Kaur and Makkar (2023) on the need for coordinated

supply chain strategies.

Regional adoption patterns shown in the donut chart underline disparities in uptake, with the World (32.08%), USA (30%), and UK (20.83%) accounting for the highest shares. This emphasizes the role of infrastructure, incentives, and policy readiness in shaping adoption, echoing findings from Jung et al. (2023) on regional inequalities in EV diffusion. The pie chart of drivetrain types further illustrates market dynamics: EVs (34.52%), BEVs (28.38%), PHEVs (24.28%), and FCEVs (12.82%). These figures align with IDTechEx (2024) forecasts of BEV dominance, while PHEVs and FCEVs serve specific needs such as long-distance travel and hydrogen refueling markets. Lastly, the line chart of growth status over time reveals a marked acceleration post-2020, demonstrating the effect of global emission reduction commitments, consumer awareness, and government subsidies, consistent with IEA (2024) data documenting record EV sales in this period. Collectively, this dashboard enables exploration of EV adoption through drivetrain, geography, and time—offering evidence-based insights for policy design and industry strategy.

### 3.2 Interpretation of EV Value Dashboard Visualization

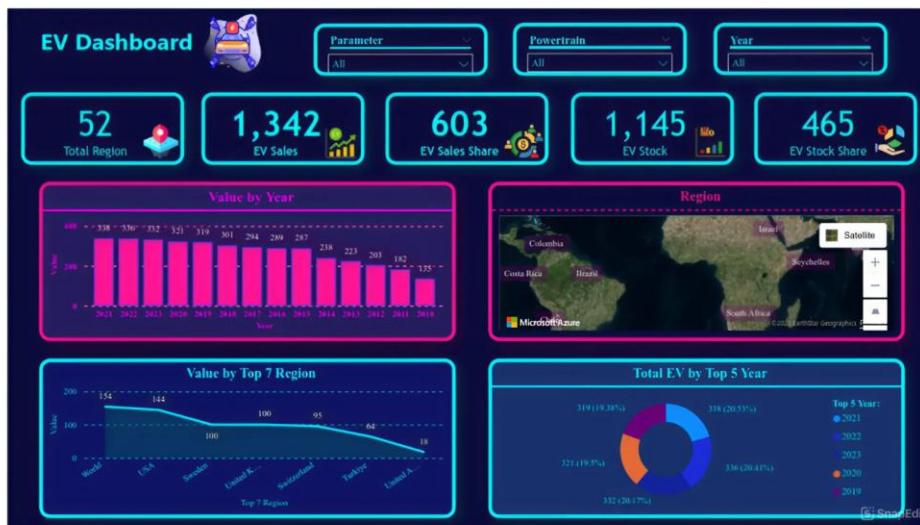


Figure 4 EV Value Dashboard

The EV Value Dashboard complements this picture by focusing on financial metrics, temporal patterns, and regional disparities that define the EV market. Key visual cards summarize metrics such as total regions covered (52), EV sales (1,342), sales share (603), stock (1,145), and stock share (465), providing a high-level snapshot of global market scope. The bar chart showing EV sales values by year indicates peak sales in 2021 (338 units), reflecting global trends in post-pandemic recovery spending and intensified government incentives. This temporal spike aligns with analyses by Singh et al. (2024), who note that targeted fiscal support can drive rapid, if uneven, adoption. The Top 7 Regions bar chart highlights the World, USA, and Sweden as leading adopters, offering evidence of how policy environments and consumer incentives shape market leadership. The prominence of Sweden underscores Europe's strong regulatory frameworks and carbon neutrality goals, aligning with Von Stumm et al. (2022) on socio-economic drivers of education and technology adoption.

The interactive map enriches this analysis by visualizing geographic disparities, enabling stakeholders to pinpoint where investments in charging infrastructure, consumer education, or policy incentives may have the highest impact. Such spatial insights are critical for addressing adoption gaps between developed and developing regions. Finally, the donut chart detailing EV adoption by the top 5 years confirms that the growth surge was most concentrated between 2020 and 2022, demonstrating sustained momentum rather than a one-time spike. This sustained growth period aligns with industry forecasts predicting continued expansion despite regional differences in policy and infrastructure readiness. Overall, the EV Value Dashboard offers stakeholders a granular view of sales dynamics, regional leadership, and temporal trends. By providing interactive, filterable data across these dimensions, it empowers evidence-based planning and targeted interventions to accelerate the transition to electric mobility in a sustainable and equitable way.

### 4. CONCLUSION

This study demonstrates that interactive data visualization using Power BI is an effective approach to illustrate global EV adoption dynamics from 2010 to 2024. The dashboards reveal consistent sales growth, regional disparities, and drivetrain diversity. For example, BEVs dominate with 28.38%, while Southeast Asia contributes less than 5% to global sales,

underscoring infrastructural challenges. By enabling filtering by year, region, and drivetrain, this approach empowers policymakers, businesses, and researchers to identify market gaps, evaluate policy impact, and plan infrastructure investments. Ultimately, the integration of structured data modeling and interactive visualization facilitates evidence-based decision-making crucial for achieving sustainable and equitable electric mobility transitions globally.

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