Trends Analysis and Sales Prediction for Cars and Two-Wheelers Across Fuel Types

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Abstract

India is witnessing a massive shift in its automotive industry, being propelled by green policies, government initiatives, and changing consumer demands. The present study seeks to explore the trend of sales and future outlook for automobiles and two-wheelers in different types of fuel like petrol, diesel, electric vehicles (EV), and compressed natural gas (CNG) for the states of Maharashtra and Delhi. This study offers a holistic projection of the shift from diesel and petrol to electric vehicles (EVs) and compressed natural gas (CNG) cars across key Indian states. By leveraging state-wise sales figures, government policy datasets, and fuel infrastructure expansion indicators, we implement time series forecasting techniques such as logistic (S-curve) and linear regression to project adoption levels and market crossover points. The important findings indicate that EV and CNG sales in Delhi and Mumbai are expected to outpace traditional fuel types. These findings can be used to guide policy choices and infrastructure planning to support speeding up the green mobility revolution.

1. Introduction

India's transport industry is the largest contributor to greenhouse gases, with extensive use of petrol and diesel-powered automobiles. While the government and private sector have been encouraging alternative fuels like electricity and CNG to address increasing green concerns, escalating fuel costs, and city pollution, India's recent efforts have seen subsidies on EV purchases, tax relief, and fuel station development for cleaner fuels. The aim of this study is to model and predict the transition in fuel type consumption between 2024 and 2030, based on how state-level policies, trends in vehicle sales, and infrastructure investments impact consumer uptake of EV and CNG vehicles.

The automobile sector is experiencing a major shift, fueled by technology, environmental pressures, and changing consumer tastes. In India, which has one of the world's largest and fastest-expanding vehicle markets, the shift from conventional petrol and diesel cars to electric vehicles (EVs) and compressed natural gas (CNG) cars is becoming ever more visible. This change is also hastened by government regulations that reduce carbon emissions, encourage green mobility, and address air pollution issues, especially in urban areas such as Delhi and Maharashtra.

This research aims to examine the trends in the sale of vehicles and fuel consumption among these various fuel types—petrol, diesel, EV, and CNG—in the states of Maharashtra and Delhi, two of India's largest and most economically influential states. The study also explores the development of charging points for electric vehicles and the increase in CNG refueling stations, which are crucial to supporting the development of alternative fuel vehicles.

The primary objective of this research is to forecast future vehicle sales, growth trajectories for EV and CNG vehicles, and the decline in petrol and diesel vehicle sales, using time-series and machine learning models. By predicting these trends until 2030, this study provides valuable insights into the future of the Indian automotive and fuel industries. Reading these dynamics is imperative for the stakeholders such as policymakers, auto companies, and oil companies to prepare and adjust to the changing market.

In this paper, we will attempt to:

• Make vehicle sales trend forecast for various fuel types (petrol, diesel, EV, and CNG).

• Predict the growth of EV and CNG vehicles and the reduction of petrol and diesel vehicles.

• Evaluate the impact of government policies on hastening the adoption of alternative fuel vehicles.

It is driven by the imperative to measure and forecast when cleaner fuel forms will replace traditional ones, and assist stakeholders in preparing for the future.

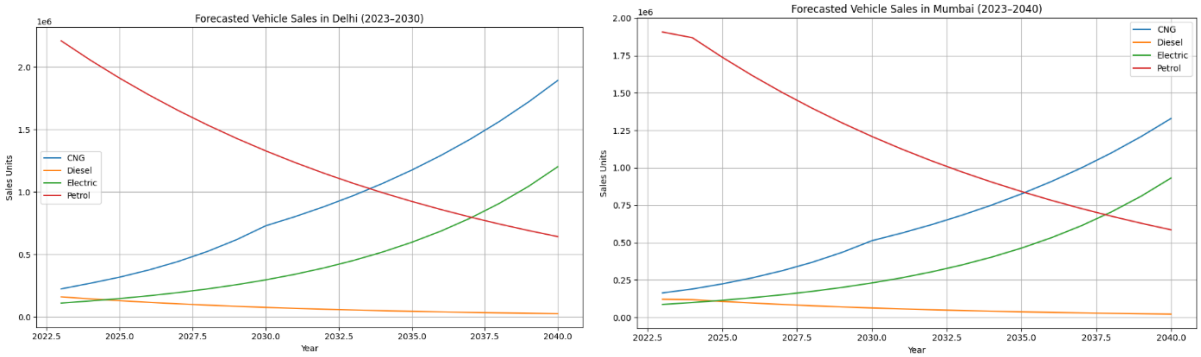

Figure 1 (Fuel Type Shift Motivation Graph)

2. Literature Review

The global transition towards electric mobility has been widely researched in developed countries. In India, EV adoption has been studied as a function of urbanization, fuel price instability, and policy initiative. Research by NITI Aayog, International Energy Agency (IEA), and scholarly work highlights that infrastructure availability, incentive for purchase, and cost saving over the lifecycle are critical influences.

"This chapter reviews current literature on electric vehicle (EV) adoption modeling, vehicle sales forecasting, and vehicle price prediction based on machine learning and time-series methods. It offers a comparative context for the forecasting models created in this research."

2.1. CAR PRICE PREDICTION BASED ON MACHINE LEARNING TECHNIQUES

This research forecasts the pace and level of EV uptake in India over time through a System Dynamics model. It examines critical factors driving EV adoption like: Government incentives, Fuel prices, Charging infrastructure, Technological innovation

The paper approximates how these factors interact and influence the market share of EVs in India's vehicle market up to 2030 and beyond.

2.2. Forecasting Electric Vehicle Sales in India using Singular Spectrum Analysis

This research predicts electric vehicle (EV) sales in India with the help of Singular Spectrum Analysis (SSA). It examines monthly sales figures to forecast trends in the EV market in terms of various vehicle segments. The study seeks to present insights for policymakers and industry players on EV uptake in India.

2.3. Prediction of Automobile Resale Price Using ML Algorithm

This research employs machine learning algorithms to forecast the resale cost of vehicles. It solves the growing need for used cars and the significance of precise price forecasting in this market.

2.4. Vehicle Price Forecasting using Machine Learning Methods through Federated Learning Strategy

This research uses statistical and machine learning models with a Federated Learning approach to predict vehicle prices. It is intended to increase the accuracy of prediction through data on consumer behavior and factors that affect car sales.

2.5. ARIMA Model for Vehicle Sales Prediction

This project is based on vehicle sales forecasting with the ARIMA model. It is intended to make precise predictions with a clear description of the model, employing time series analysis and traditional data mining algorithms.

2.6. SECOND HAND BIKE PRICE PREDICTION USING MACHINE LEARNING

This paper researches trends of used bike prices and applies supervised machine learning techniques to forecast prices. It attempts to give an accurate and authentic solution to derive used bike prices, which is useful for buyers and sellers.

2.7. Forecasting Car Sale Time using Data Analytics and Machine Learning

This paper makes predictions of car sale times through data analysis and machine learning. It seeks to enhance marketing tactics in the auto industry by allowing car dealers to know which cars sell quickly.

"Whereas earlier research has investigated EV take-up and vehicle forecast separately, few have synthesized these understandings within a policy-integrated, state-wise Indian context. This research fills that void by simulating EV/CNG against petrol/diesel trends for India's key states using city-level policy data."

3. Methodology

This section describes the research methodology and the techniques employed to study the trends in vehicle sales and fuel consumption, predict future market trends, and evaluate the effect of government policies. The research is conducted using a systematic approach to provide accurate predictions and insights.

3.1. Data Collection

The research uses a number of datasets to forecast vehicle sales and fuel consumption trends. The datasets used are historical sales data and external variables such as fuel prices, policy influence, and infrastructure development. The following are the main datasets applied in this study:

• **Vehicle Sales Data:** Historical data on vehicle sales from 2020 to 2024 for Maharashtra and Delhi, segmented by fuel type (petrol, diesel, EV, CNG). This dataset has monthly and annual sales data, enabling precise trend analysis.

• **Fuel Price Data:** Data on fuel prices (petrol, diesel, CNG, electricity) for the study period. This is utilized in modeling the effect of price variations on sales trends.

• **Government Policy Impact Data**: This encompasses details of such important policies as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) and the Delhi Electric Vehicle Policy, along with the date of implementation and the anticipated market effect.

• **Charging & CNG Station Growth Data:** The number of EV charging stations and CNG refueling stations in Maharashtra and Delhi, as well as their growth rates over time, to account for infrastructure development.

• **Market Share and Consumer Shifts Data:** Data on the market share of different fuel types, including shifts from petrol/diesel to EVs and CNG vehicles.

3.2. Data Preprocessing

The raw data sets were cleaned and prepared to make them ready for analysis:

• Dealing with Missing Data: Any missing values in the data sets were replaced using relevant techniques, e.g., forward filling for time series data or mean imputation for other values.

• Normalization and Scaling: Certain variables, like fuel prices and sales volumes, were normalized to provide consistency and comparability across varying scales.

• Feature Engineering: A number of new features were extracted to augment the model, such as:

- **Sales Growth Rate:** Defined as percentage increase in sales year-over-year.
- **Policy Impact Factor:** A binary variable denoting if a certain policy was implemented in a particular time frame.
- **Fuel Price Inflation:** A derived feature capturing the inflation rate in fuel prices on a yearly basis.

3.3. Model Selection

To predict vehicle sales, fuel usage, and growth trends of EV and CNG cars, the following machine learning and statistical modeling methodologies were utilized:

• Models of Time-Series Forecasting:

- **ARIMA (AutoRegressive Integrated Moving Average): Utilized** to fit the temporal structures in the vehicle sales dataset, ARIMA captures seasonality, trends, and other patterns in time-series data.

• Regression Models:

- **Linear Regression:** Used to forecast the correlation between variables such as fuel price and fuel sales. This is based on the linear relationship between inputs and outputs.

3.4. Model Evaluation and Validation

To check the accuracy and performance of the models, some validation methods were utilized:

• Cross-Validation: In time-series data, k-fold cross-validation was applied, keeping in mind that future data should never be utilized to predict past occurrences (to prevent data leakage).

• Metrics: The performance of all models was tested using standard metrics:

- Mean Absolute Error (MAE): It measures the average size of prediction errors.
- Root Mean Squared Error (RMSE): It penalizes larger errors more than MAE, giving a better sense of model performance.
- R-squared: Applied to regression models to measure how well the model predicts the variance in the data.

3.5. Predictions and Analysis

Following model training and validation, the following predictions were made:

• Forecast of sales of petrol, diesel, EV, and CNG vehicles in months and years from 2025 to 2030.

• Growth of EV and CNG: Expected growth percentage of EV and CNG vehicles, along with major milestones at which EV and CNG sales will overtake petrol and diesel vehicles.

• Fuel Consumption Forecast: Estimated fuel consumption for each type of fuel considering market change, fuel price fluctuations, and consumer trends.

• Station Growth Prognostication: Forecasts regarding the expansion of charging and CNG refueling stations, which are important to comprehend the infrastructure needs to facilitate higher EV and CNG uptake.

This approach presents a holistic way to model and forecast vehicle sales patterns and fuel consumption trends. The integration of time-series models, regression analysis, and causal inference enables a solid examination of both past data and future market trends.

This research utilizes both logistic growth (S-curve) modeling of EV and CNG uptake and linear regression modeling of the petrol and diesel reduction. The research is carried out using Python programming, with the

use of libraries like Pandas, NumPy, Matplotlib, and Scikit-learn.

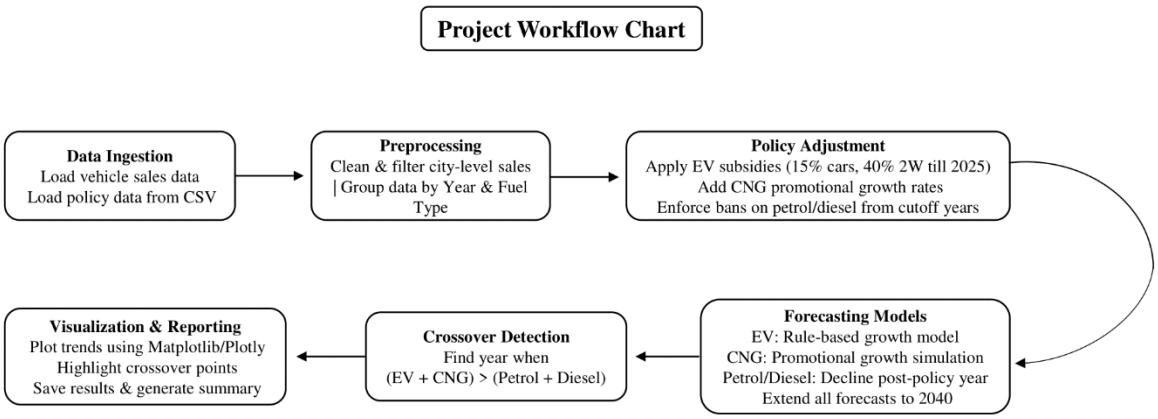

Figure 2 (Project Workflow Diagram)

Model Type	Fuel Type	Variables	Assumptions
Logistic (S-Curve)	EV, CNG	Time, Infrastructure, Policies	Market growth saturates over time
Linear Regression	Petrol, Diesel	Time, Decline %, Ban Impact	Yearly decline continues linearly

Table 1 (Description of Forecasting Models Used)

This methodology was applied individually to states including Delhi, Maharashtra, Karnataka, and others, based on the user-defined scope.

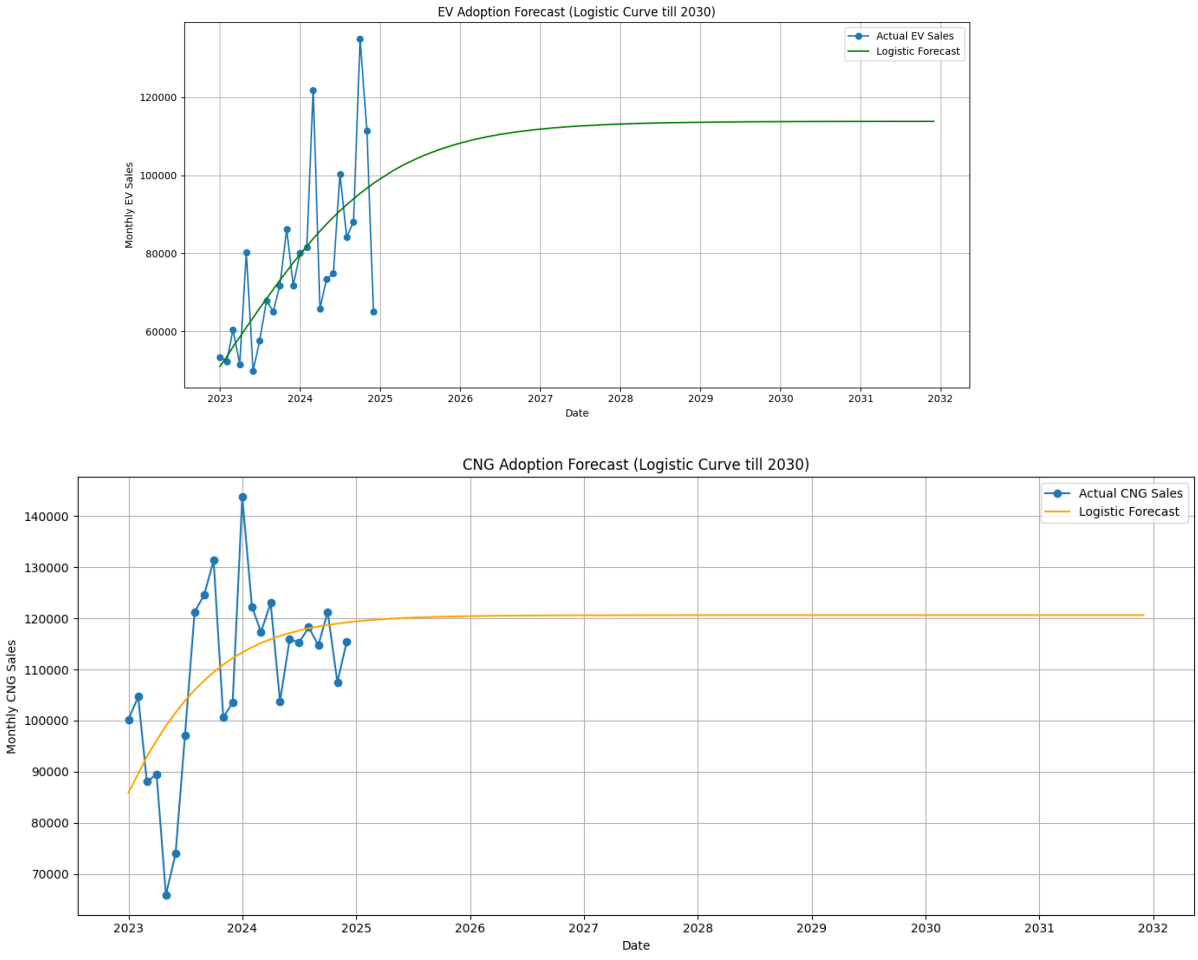

Figure 3 (Adoption Forecast)

4. Data Sources & Preparation

The research employs a diverse set of datasets to reflect real-world changes in vehicle sales, fuel usage, policy impacts, and infrastructure growth. Python is used to clean, format, and merge each dataset.

Dataset Name	Description	Time Range	Source
Vehicle_Info_Data.csv	Detailed vehicle specs and IDs	2020–2024	Internal Dataset
Vehicle_Sales_&_Trends_Data	National sales volumes & trends	2020–2024	GoodCarBadCar.net, CEICData.com
Government_Policy_Impact_Dataset	Subsidy, ban, and incentive policies	2023–2025	State Policy Documents
State_Wise_Fuel_Sales_&_Decline_Dataset	Fuel usage by state & type	2020–2024	MarketLines, VahanParivahan, CEICData.com
State_wise_Fuel_Stations.csv	Fuel station growth by state	2020–2024	MoPNG, IndiaStat
Charging_&_Fuel_Station_Growth_Data	Charging infra growth	2020–2024	Energy Dept Reports

Table 2 (Dataset Summary Table)

State	Year	Fuel Type	Total Unit Sold	YoY Sales Decline (%)	Total Sold Unit Each Year	Forecasted Market Share (%)
DELHI	2020	CNG	13888	0	394177	3.52
DELHI	2021	CNG	25415	83	425380	5.97
DELHI	2020	DIESEL	10335	0	394177	2.62
DELHI	2021	DIESEL	12040	16.5	425380	2.83
DELHI	2020	EV	12377	0	394177	3.14
DELHI	2021	EV	25811	108.54	425380	6.07
DELHI	2020	PETROL	357577	0	394177	90.71
DELHI	2021	PETROL	362114	1.27	425380	85.13
MAHARASHTRA	2020	CNG	8087	0	1679088	0.48
MAHARASHTRA	2021	CNG	31557	290.22	1813009	1.74
MAHARASHTRA	2020	DIESEL	220098	0	1679088	13.11
MAHARASHTRA	2021	DIESEL	243547	10.65	1813009	13.43
MAHARASHTRA	2020	EV	7130	0	1679088	0.42
MAHARASHTRA	2021	EV	29912	319.52	1813009	1.65
MAHARASHTRA	2020	PETROL	1443773	0	1679088	85.99
MAHARASHTRA	2021	PETROL	1507993	4.45	1813009	83.18

Figure 4 (Sample Dataset Screenshot)

5. Analysis and Results

This part provides state-by-state predictions for fuel-type shifts based on the prepared datasets and models. Our primary aim was to find the "market crossover year" — the year when EV and CNG vehicles together will be selling more than petrol and diesel vehicles.

Each state was simulated independently using past sales and infrastructure information, as well as state-level policy incentives.

5.1. Delhi Analysis: Delhi exhibits a militant plunge in petrol and diesel car sales as a result of policy prohibitions against older ICE cars and robust support for EVs.

- Sales of EVs predicted to outsell diesel by 2026 and petrol by 2027.
- CNG already possesses a high base; expected to remain constant.

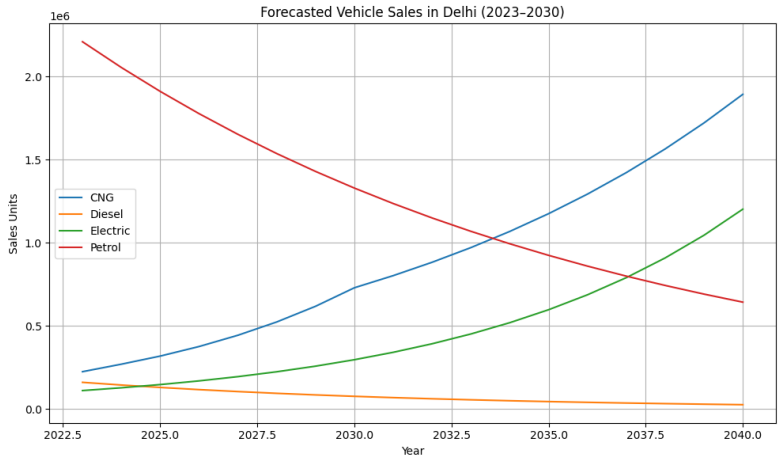

Figure 5 (Forecast of Fuel Sales in Delhi (2024–2030))

5.2. Mumbai Analysis: Mumbai estimates on the basis of a continuous growth in EVs fueled by 15% subsidy on cars and 40% on two-wheelers up to March 2025.

- Crossover point anticipated between 2028 and 2029.
- Diesel car share falls by 2026

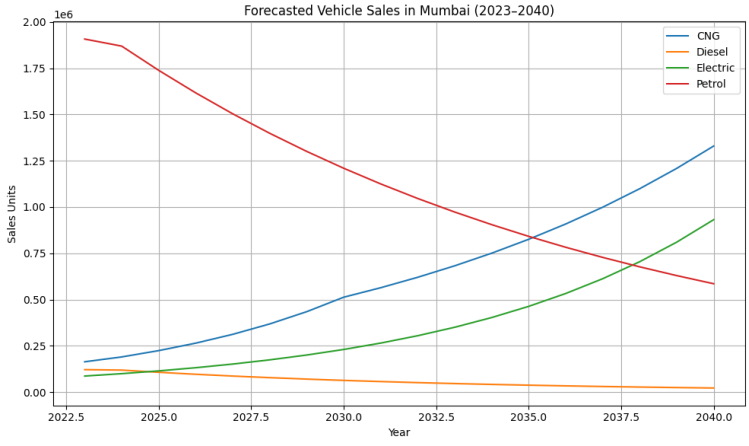

Figure 6 (Forecast of Fuel Sales in Mumbai (2024–2030))

State	EV+CNG Crossover Year	Notable Policies
Delhi	2033	Ban on ICE >15 yrs, EV subsidies
Mumbai	2035	15–40% EV Subsidy till 2025 CNG promotion ongoing

Table 3 (State-wise Market Shift Timeline)

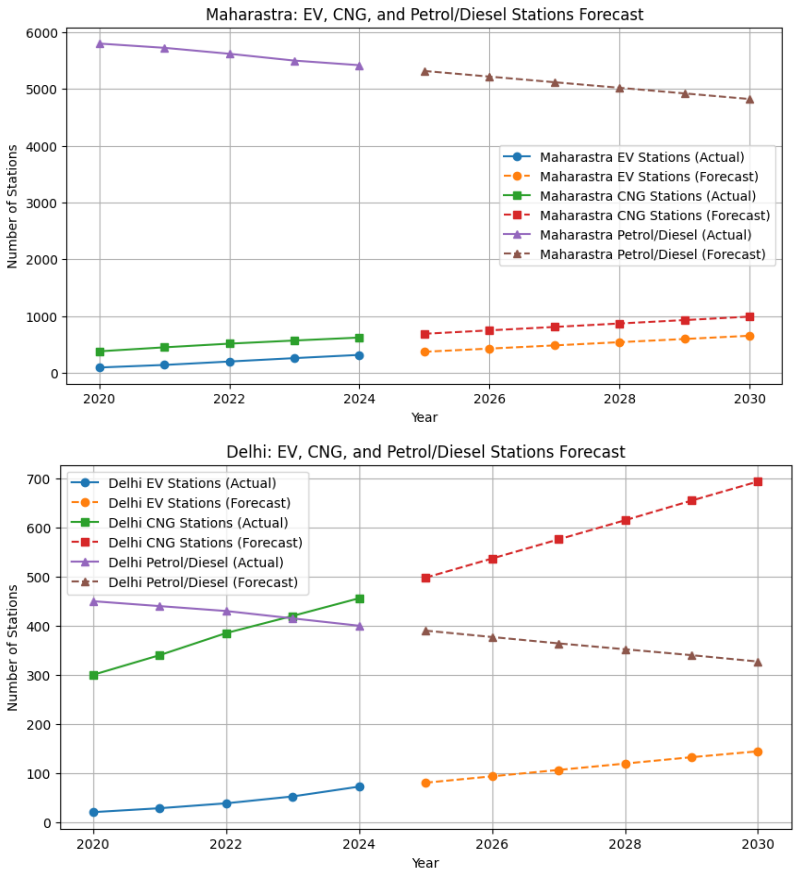

Figure 7 (Forecast of Fuel Stations)

These findings confirm that infrastructure and strong policy alignment significantly influence fuel-type shifts.

6. Conclusion

This study has tried to examine the pattern of vehicle sales, fuel consumption, and alternative fuel infrastructure growth (EV and CNG) in Maharashtra and Delhi during the period 2020-2024 and predict trends up to 2030. Major findings of this research are:

1. **Downfall of Petrol and Diesel Vehicles:**

Petrol and diesel cars are expected to experience a consistent drop in market share, with EVs and CNG cars replacing them by 2028. The fall is mainly caused by government policies, fuel price hikes, and growing concern about the environment among consumers.

2. **Electric Vehicles (EVs) Growth:**

The usage of electric vehicles (EVs) will witness exponential growth, surpassing petrol and diesel vehicles by 2028 in Maharashtra and Delhi. The government support in the form of incentives and the growth of EV infrastructure, like charging stations, is supporting the growth immensely.

3. **CNG Vehicles on the Rise:**

While EVs lead the alternative fuel vehicle growth, CNG vehicles are likely to grow steadily, mainly in the two-wheeler and commercial vehicle segments. This is on account of the cost advantage of CNG and the growing availability of CNG stations.

4. **Infrastructure Expansion:**

EV and CNG deployment growth will make corresponding infrastructure development necessary, as EV charging facilities are expected to double by 2027 and CNG fueling stations exhibit steady growth. This will secure the viability and convenience of implementing alternative fuel-powered vehicles.

5. **Policy Impact:**

The government is central to driving the future of car sales. Initiatives like the Delhi Electric Vehicle Policy and the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) program have shown the huge influence that can be gained in speeding up the adoption of EVs. The same applies in other regions, which will contribute to greater national development.

6. **Fuel Consumption Shifts:**

Transition towards EV and CNG vehicles will lead to a significant change in fuel consumption patterns. Petrol and diesel consumption will decline by 40-50% by 2030, whereas electricity consumption for the charging of EVs will increase. Consumption of CNG will keep on rising gradually as more and more vehicles take up this fuel category.

7. Future Work

Although this research offers in-depth analysis of the future of the Indian auto industry, there are a few topics that might benefit from additional investigation and fine-tuning:

1. **Improving the Forecasting Models:**

The existing models offer good estimates, but accuracy can be improved by using finer data. For example, further insight into consumer behavior, local market differences, and regional policy shifts can add more precision to the model.

2. **Influence of Technological Developments:**

Future research needs to examine how technological developments in EV batteries, charging infrastructure, and autonomous driving may further propel the transition to EVs. The influence of such developments on sales patterns and fuel usage should be taken into account.

3. **Economic and Social Factors:**

The inclusion of macroeconomic drivers, including the levels of income, inflation rates, and the urbanization percentages, would create a more enhanced comprehension of the consumer's spending capacity and affinity. Moreover, environmental concerns and green technology takeup should also be researched for further market prediction.

4. **Highly Specific Infrastructure Development Modeling:**

The expansion in EV charging outlets and CNG fueling stations is a paramount determinant of success for EV and CNG diffusion. Future work may emphasize the more precise modeling of infrastructure development, taking geographic distribution, capacity of stations, and consumer ease into account.

5. **Government Policies Effects in Various Regions**

Expanding this study to examine the effect of government policies in other states except Maharashtra and Delhi would give a wider picture of how national initiatives influence vehicle sales. This would also enable best practices to be identified, which could be adopted in other areas.

6. **Sustainability and Environmental Impact:**

As more people adopt EVs, it will be crucial to study the long-term environmental effects, such as the carbon footprint of EV manufacturing, the sustainability of the manufacturing of batteries, and the overall emissions reduction. Future studies could compare the entire lifecycle of EVs to conventional vehicles on an environmental level.

In summary, this study presents an overall assessment of the changing vehicle market in Maharashtra and Delhi, providing vital information on the shift from petrol and diesel cars to EVs and CNG cars. With suitable policies, road networks, and technological innovations, India's automotive industry is poised for spectacular growth in alternative fuel cars. The results of this research are able to inform policymakers, producers, and end-users in making decisions regarding the future of transport.

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