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Forecast of the development of the electric vehicle market in the republic of Kazakhstan until 2030

Natalya Tokmurzina-Kobernyak[1], Aisha Mussabekova[2], Olga Kisselyova[1*], Muslim Aikumbekov[1], Seidulla Abdullayev[1]

[1]Satbayev University, Almaty, Kazakhstan.
[2]Almaty Management University, Almaty, Kazakhstan.

Corresponding author: Olga Kisselyova (*Email:* *o.kisselyova@satbayev.university*)

Abstract

The article presents a comprehensive analysis of the current trends and future prospects for the development of the electric vehicle (EV) market in the Republic of Kazakhstan through 2030. The study integrates an examination of the regulatory environment, the existing charging infrastructure, as well as the identification of key barriers and enabling factors influencing market growth. Utilizing a combination of forecasting methodologies—including logistic growth models, the Bass diffusion model, exponential smoothing techniques, and polynomial regression—the research provides scenario-based projections of the EV fleet size. Results indicate a potential expansion ranging from 37,000 to 120,000 electric vehicles by 2030, depending on the intensity of policy support and market dynamics. The analysis highlights critical success factors necessary for the effective implementation of both governmental policies and private sector initiatives aimed at promoting low-carbon transportation. These findings offer valuable insights for policymakers, industry stakeholders, and researchers engaged in the sustainable development of Kazakhstan's automotive sector, emphasizing the importance of coordinated efforts to overcome infrastructural and regulatory challenges in fostering the widespread adoption of electric vehicles.

Keywords: Charging infrastructure, Electric vehicle, Forecasting, Scenario analysis, Sustainable development, Transport policy.

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1. Introduction

In the context of the global transition toward sustainable development, particular attention is given to the promotion of environmentally friendly modes of transportation, including electric vehicles (EVs). International practice demonstrates the crucial role of government support and regulatory frameworks in fostering the advancement of these technologies.

Over the past decade, electric vehicles have evolved from a niche product into a mainstream market segment. In 2024 alone, global EV sales reached nearly 17 million units, bringing the total EV stock to more than 57 million units. Forecasts suggest that by 2025, global EV sales will surpass 20 million, accounting for over one-quarter of all automobiles sold worldwide [1].

Kazakhstan significantly lags behind global leaders in the EV sector (such as China, the United States, and the European Union), both in terms of the number of electrified vehicles and the development of the charging infrastructure necessary to support their operation. Therefore, identifying the key drivers of EV adoption that are relevant to Kazakhstan's specific context, along with potential projections for the domestic EV fleet, represents a highly relevant research task.

According to international experience (EU, USA, China, CIS [2-4]), electric vehicles can be classified by powertrain type as follows:

- BEV (Battery Electric Vehicle): A mechanically driven vehicle powered solely by an electric motor that obtains energy from rechargeable batteries, capacitors, and/or fuel cells, and can only be charged from an external electricity source.
- HEV (Hybrid Electric Vehicle): A vehicle equipped with a hybrid powertrain combining an internal combustion engine (ICE) and an electric drive with a battery that is not designed for external charging (charging occurs via the ICE and regenerative braking).
- PHEV (Plug-in Hybrid Electric Vehicle): A hybrid vehicle (ICE + electric drive with a battery) that can be charged from the external grid in addition to charging via the ICE.
- EREV (Extended-Range Electric Vehicle): An EV with an ICE-based generator that extends the driving range.
- FCEV (Fuel Cell Electric Vehicle): A road vehicle with an electric drivetrain, powered by a rechargeable battery system and fuel cells (typically hydrogen-based) as the primary source of traction power.

The International Energy Agency (IEA) annually provides global forecasts on EV development [5]. Figures 1–4 illustrate the key indicators of the current global EV stock according to IEA data.

Figure 1 presents the cumulative growth dynamics of the global EV fleet along with projections up to 2030. The data clearly indicate that since 2020, EV adoption has followed an exponential growth trend. Between 2020 and 2024, the global EV fleet expanded nearly sixfold, reaching 58 million units by 2024 [6]. According to IEA forecasts, the number of EVs worldwide could exceed 240–250 million units by 2030.

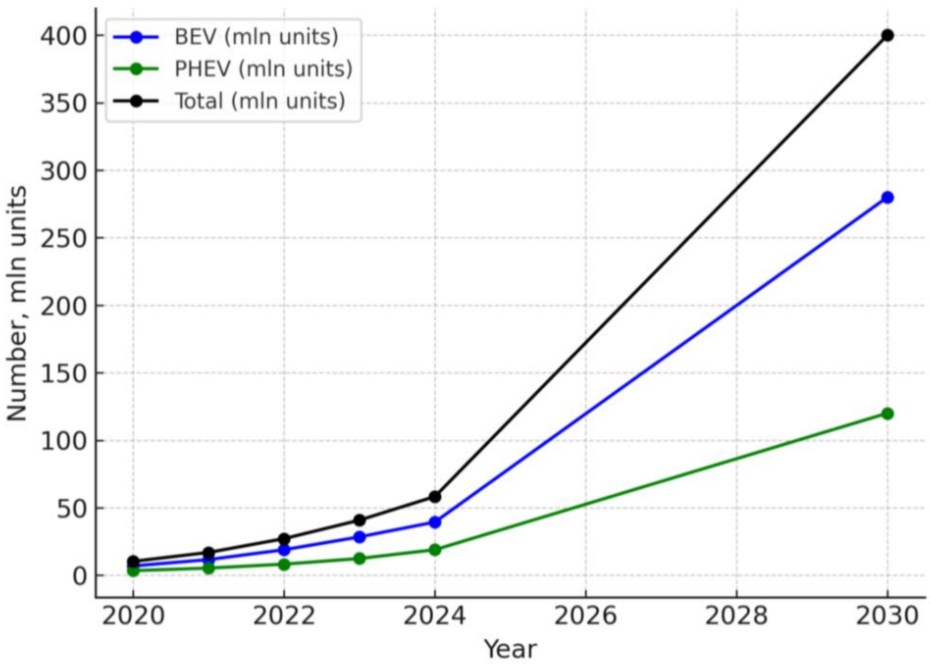


Figure 1.
Dynamics of the global electric vehicle fleet and projections up to 2030.

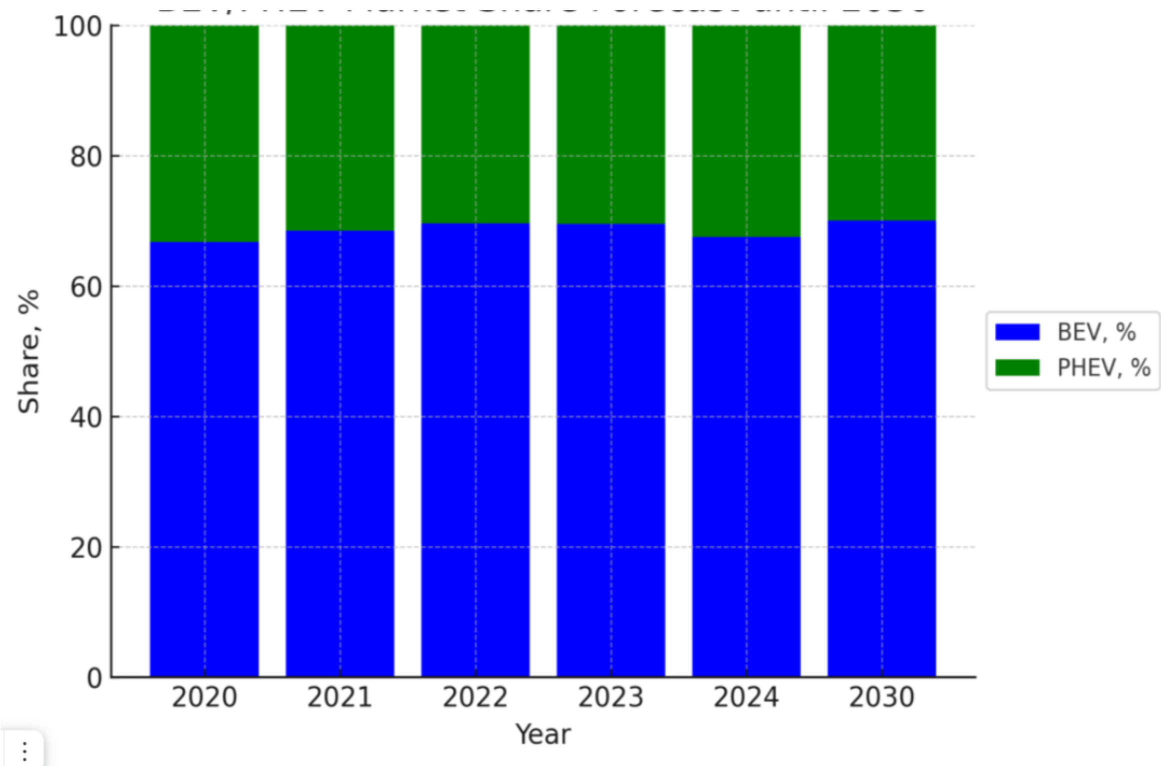


Figure 2.
Ratio of BEVs and PHEVs and projections up to 2030.

Figure 2 illustrates the changing shares of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) in both overall sales and the total vehicle fleet. The share of BEVs demonstrates a steady increase, rising from 66.7% in 2020 to a projected 70% in 2030. Conversely, the share of PHEVs is expected to decline from 33.3% to 30% over the same period [7].

As shown in Figures 3–4, the distribution of the global EV fleet is dominated by China, the United States, and Europe. China alone accounts for more than half of the world's EV stock (57%).

In addition, the compound annual growth rate (CAGR) of EV sales over the past five years is provided for selected regions and countries [8, 9]:

- Europe – 45.40%;
- China – 64.42%;
- Russia – 73.83%;
- United States – 37.85%;
- Other regions – 53.30%.

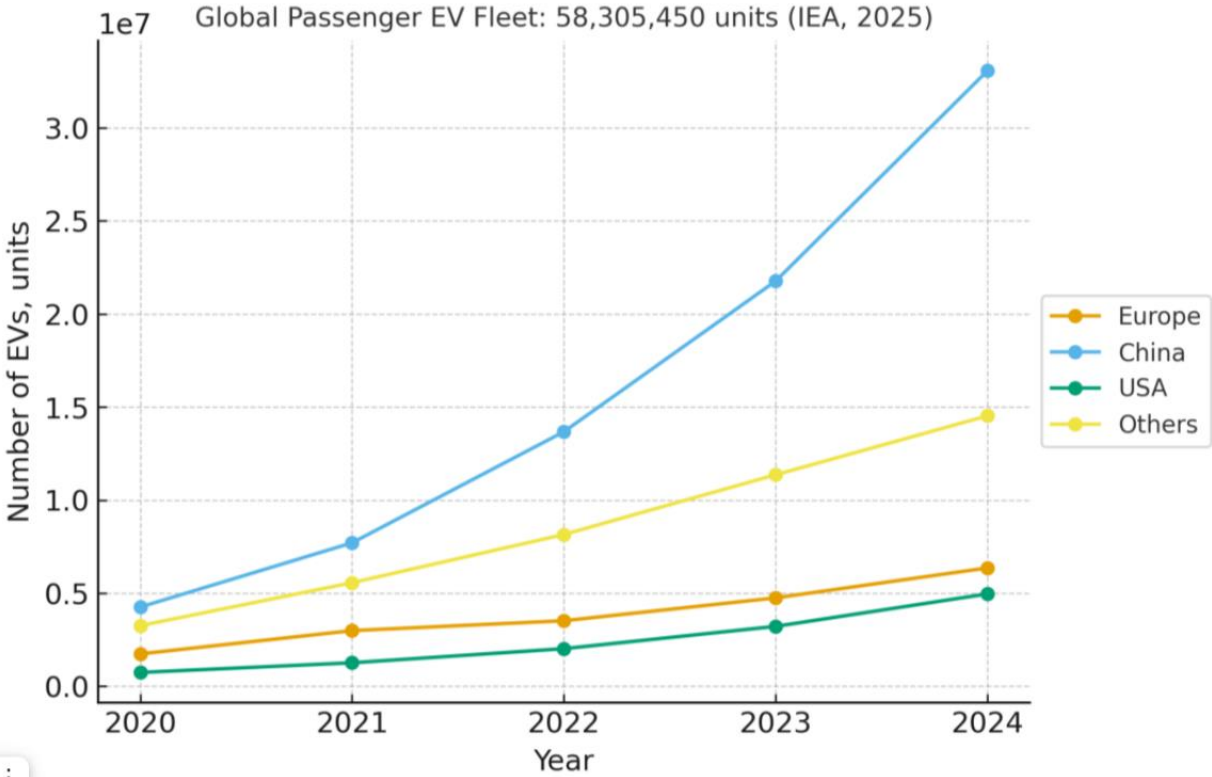


Figure 3.
Dynamics of the passenger electric vehicle fleet, number of units.
Source: International Energy Agency (IEA) [5].

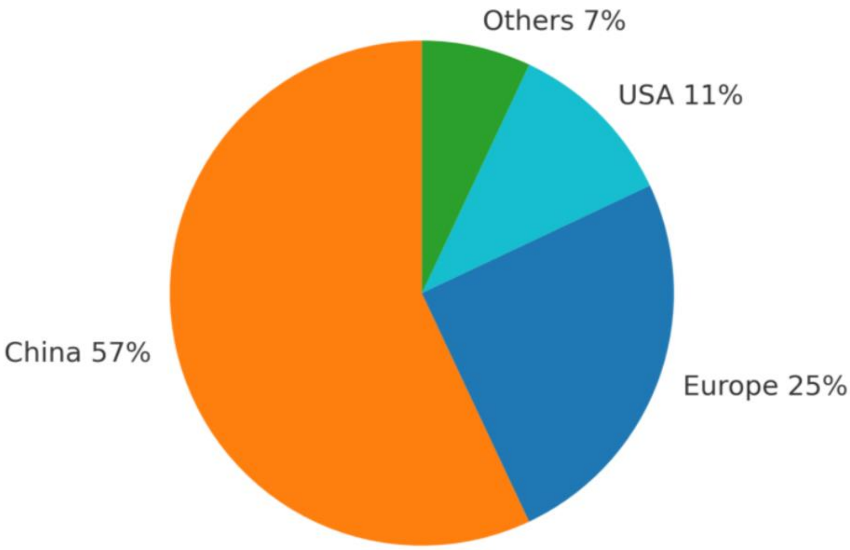


Figure 4.
Distribution of the passenger electric vehicle fleet by countries and regions in 2024.

EV sales in 2025 are expected to exceed 20 million units, accounting for more than one-quarter of all automobiles sold worldwide [10, 11].

The statistical analysis of the electric vehicle fleet in the Republic of Kazakhstan is based on data provided by the Bureau of National Statistics of the Republic of Kazakhstan (BNS RK), as well as information from open sources, including media publications, analytical reports, and other publicly available materials [12, 13]. The key statistical indicators of Kazakhstan's EV fleet are presented in Figures 5–8.

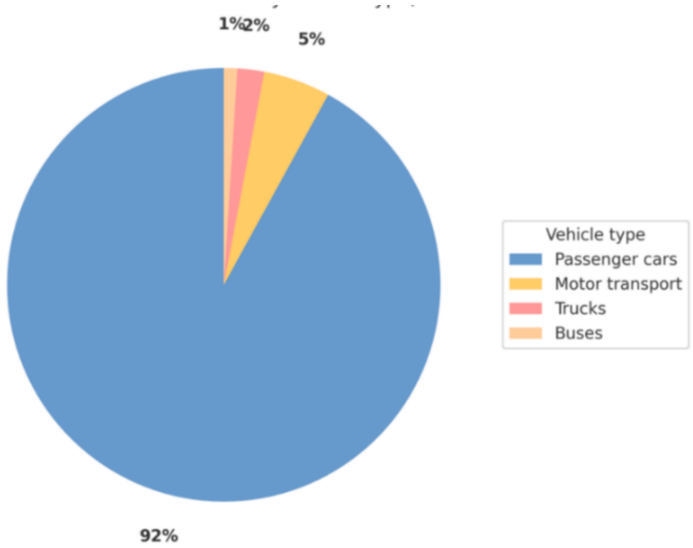


Figure 5.
Distribution of electric vehicles by type.

As shown in Figure 5, the EV fleet in Kazakhstan is predominantly composed of passenger cars, accounting for over 90% of the total stock. Electric buses and trucks currently represent a small share, yet their numbers are gradually increasing: buses are mainly utilized in urban public transportation (Astana, Almaty, Shymkent), while trucks are employed in logistics. Electric motorcycles and specialized machinery remain isolated cases. Thus, Kazakhstan's transport electrification is concentrated in the passenger segment, although early signs of diversification are evident in public transport and commercial freight [14].

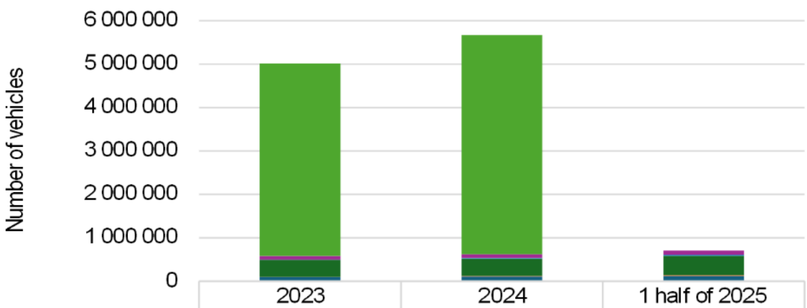
The distribution of the passenger car fleet by fuel type (Figure 6) reveals the following structure:

- Gasoline-powered vehicles remain dominant, accounting for approximately 88–90% of the fleet.
- The share of diesel-powered vehicles is declining, currently at around 2%.
- Hybrid vehicles make up about 8%, demonstrating steady growth.
- Electric vehicles represent less than 1% of the total fleet.

Despite recent growth, EVs remain a niche form of transportation, while hybrids play the role of a transitional technology. In the coming years, accelerated transformation is anticipated, driven by state policy support and the expansion of charging infrastructure [15].

The regional ranking of Kazakhstan's EV fleet (Figure 7) highlights the following distribution:

- The clear leader is Almaty, accounting for nearly 60% of the total EV stock.
- The second-largest share belongs to Astana (around 12%).
- Shymkent and Almaty region each account for approximately 4–5%.
- In all other regions, the share does not exceed 3% per region.



	2023	2024	1 half of 2025
Gasoline	4 437 617	5 046 114	
Diesel	86 772	91 117	101 103
Gas	6 782	10 073	13 474
Hybrid	385 847	400 138	451 506
Electric	7 997	12 664	19 078
Unspecified fuel	95 526	108 514	118 547

Figure 6.
Distribution of the passenger car fleet by fuel type.

The concentration of electric vehicles is observed primarily in metropolitan areas, particularly in Almaty, where the charging infrastructure is relatively well developed. By contrast, most regions remain on the "periphery" underscoring the need for a more balanced expansion of charging station networks across the country.

The dynamic growth of the EV market is driven by three main factors:

1. Government policy, which simultaneously tightens environmental regulations on harmful emissions and subsidizes the transition to EVs, including the development of charging infrastructure;
2. Automotive manufacturers, which are investing heavily in the development of electrified transport in order to secure a share of this promising market;
3. Consumers, who are becoming increasingly demanding in terms of both environmental performance and economic efficiency of vehicles, with many now willing to switch to EVs.

An analysis of international experience demonstrates that the evolution of EV markets across countries generally follows a typical three-stage trajectory [16]:

1. Subsidy-driven paradigm: EVs remain expensive, their share of new car sales is limited to 2–3%, and significant consumer subsidies are required;
2. Transition to the mass market: EV sales grow sharply to account for several tens of percent of new sales; EVs successfully compete with conventional vehicles on price, while subsidies become an additional—rather than decisive—factor;
3. Free-market paradigm: the EV industry operates without direct subsidies, and both manufacturers and society derive the full benefits of large-scale transport electrification.

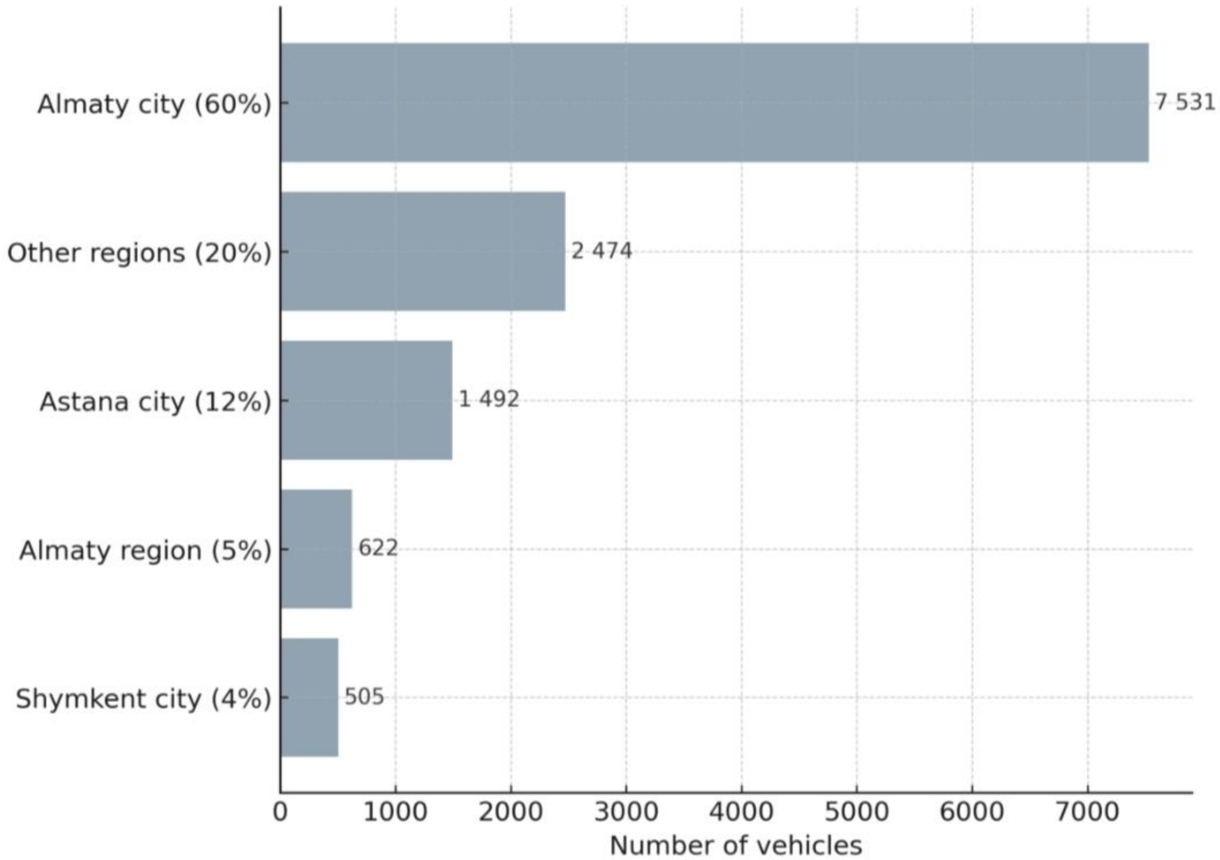


Figure 7.
Ranking of Kazakhstan's regions by number of electric vehicles (2024).

The third stage has not yet been implemented anywhere in the world and therefore remains a prospective concept. However, the successful passage of the first two stages by a number of countries has made it possible to accumulate knowledge about the mechanisms and patterns of these processes, as well as the most effective instruments that governments can employ to support them [17].

The main measures of state support are summarized in Table 1.

The development of electric transport is a strategic priority of Kazakhstan's environmental and energy policy, aligned with the UN Sustainable Development Goals and the "Strategy for Achieving Carbon Neutrality by 2060." Despite the market being at an early stage (with the share of EVs in new car sales not exceeding 1% in 2023), a steady upward trend is observed. For example, while only a few hundred EVs were registered in the country in 2021, by mid-2025 the fleet exceeded 20,000 units.

In recent years, numerous quantitative methods for forecasting the EV fleet have been developed. Early approaches relied on classical diffusion models (e.g., the logistic S-curve, Bass model) as well as statistical time series techniques (ARIMA, exponential smoothing, and others) [18].

Table 1.
Measures of electric vehicle support in different countries.

Support measure	Country implementing the measure
Purchase subsidies	United Kingdom – 7,800 USD; India – 2,400 USD; Ireland – 5,000 EUR; Spain – 25% of the price, but not more than 6,000 EUR; Canada – 4,000 USD; China – 10,000 USD; Netherlands – up to 5,000 EUR for commercial vehicles; France – 30% of the price, but not more than 7,000 EUR; Sweden – 4,200 EUR; Japan – 8,500 USD
Tax deduction upon purchase	Belgium – 30% of the price, but not more than 9,000 EUR; USA – up to 7,500 USD (with additional subsidies available in many states)
Exemption from vehicle tax	Austria – 100%; Greece – 100%; Italy – 100% for the first 5 years of ownership, then 75%; China – 100%; Netherlands – 100%; Czech Republic – 50% for commercial vehicles
Exemption from registration tax	Netherlands; Norway; Portugal; Japan
Free parking	Germany; Norway
Access to bus lanes	Germany; Norway
Free access to toll roads	Norway; United Kingdom – free entry to central London; Japan
Zero VAT rate	India – 0%; Iceland – 0% for vehicles priced up to 40,000 EUR; Norway – 0%
Exemption from import duties	Switzerland
Financial support for the electric vehicle industry	Government grants for research and development (Finland); government subsidies for the development of charging infrastructure (France, Belgium, Croatia, Denmark, Germany, Ireland, Italy, Spain, Sweden, Switzerland, United Kingdom, USA, Japan); tax deductions for private operators (France)
Local government actions to support the use of electric vehicles	Government procurement of electric vehicles (United Kingdom, Czech Republic); provision of free parking spaces for electric vehicles (Germany, Bulgaria, Latvia, Cyprus, etc.); provision of free charging at public stations (Bulgaria, Czech Republic, Denmark); access to restricted zones or city centers for low-emission vehicles (Italy, Greece)

As data have accumulated and market dynamics have become more complex, the focus of forecasting approaches has shifted toward machine learning, and particularly deep neural networks. Consequently, a variety of forecasting model classes for projecting the number of electric vehicles are now available [5, 7-11].

Different ministries and agencies have produced their own forecasts for the development of EV fleets (Figure 8). The target parameters for EV adoption in many countries are determined on the basis of commitments to reduce greenhouse gas emissions under various international agreements, most notably the 2015 Paris Climate Conference (COP21) [7]. For example, the International Electric Vehicle Initiative (EVI) [8] established within the framework of the IEA, set a target of reaching 20 million EVs worldwide by 2020. The Paris Declaration set even more ambitious goals of 100 million EVs by 2030 and 400 million units of electric transport [9]. The IEA forecast defined an even higher target of 150 million EVs by 2030 (Figure 5) [10]. However, many of these forecasts ultimately proved to be highly underestimated.

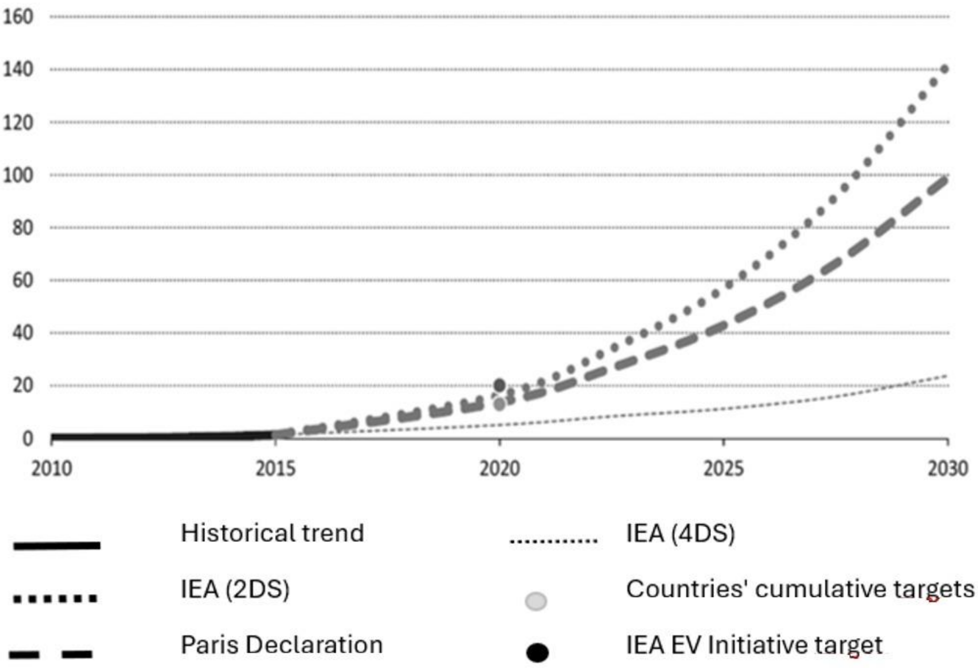


Figure 8.
Forecasts and target parameters for the development of the global electric vehicle market for the period 2010–2030, million units.
Source: Global EV Outlook [9].

Let us compare the accuracy of several scenarios against the following actual data:

- 2020: approximately 10 million electric vehicles on global roads.
- 2023: nearly 14 million new EVs registered during the year, with the total fleet reaching ~40 million units [19].
- 2024: sales exceeded 17 million units, bringing the global EV stock to nearly 58 million vehicles (IEA estimate, cited in industry media/reports).

Based on the analysis, the following conclusions can be drawn regarding the quality of forecasts between 2015 and 2023:

- Systematic underestimation of early forecasts: in 2015–2017, the central IEA scenarios targeted 100–150 million EVs by 2030; however, the actual 2020–2024 dynamics exhibited a steeper “S-shaped” segment of the adoption curve, prompting upward revisions in the models (toward ~250 million).
- Campaign targets (EVI 20-by-20) overestimated short-term adoption rates: the market did not reach the 2020 goal, but subsequently “caught up,” with the fleet growing by nearly 48 million units between 2021 and 2024 to reach ~58 million.
- Convergence of “central” forecasts after 2018: IEA 2019/2020 and BNEF 2023 produce similar estimates of ~240–250 million EVs by 2030. Considering the 2024 data, this target appears realistic, though it will require accelerated sales of 30–40+ million units per year by the end of the decade.

Key factors contributing to deviations between forecasts and actual outcomes include:

- Policy and subsidies/tariffs: changes in incentives, localization requirements, and trade barriers created significant discrepancies between the US/EU and China. The IEA notes risks of slowdown if policy support weakens.
- Price and vehicle mix: in China, a majority of BEVs are already cheaper than ICE counterparts, accelerating market penetration; in the US/EU, the price gap persisted longer.
- Infrastructure: record additions of charging points in 2024 (+>1.3 million public stations) acted as a major driver, although regional imbalances remain.

In Kazakhstan, attempts have also been made to forecast EV fleet growth. We analyzed forecasts produced in 2023 by the Ministry of Energy of the Republic of Kazakhstan, the Ministry of Internal Affairs, KazAvtoProm, and Satbayev University [12, 13] (Table 2).

Table 2.
Forecasts of the electric vehicle fleet in Kazakhstan.

Source	**Forecast for 2025**	**Forecast for 2028–2030**	**Comment**
Ministry of Energy of the Republic of Kazakhstan [20]	1 125	6 267 (by 2030)	Actual 2025 value exceeded the forecast by more than 10 times
Ministry of Internal Affairs of the Republic of Kazakhstan [21]	–	40 000 (by 2028)	Achievable at the current growth rate
KazAvtoProm [22]	–	35–40 thousand (by 2029)	Сценарий выглядит достижимым
Satbayev University [23]	17 000	61130 (by 2030)	Achievable at the current growth rate
Actual data according to BNS RK (2025)	20 775	–	

Key Published Scenarios in Kazakhstan (2020–2025)

- Ministry of Energy of the Republic of Kazakhstan (conservative scenario, 2023): 1,125 EVs by 2025; 6,267 by 2030; 40,000 by 2035; see also aggregated presentation in AIFC analytics (2030/2035).
- Ministry of Internal Affairs of the Republic of Kazakhstan (moderately optimistic scenario, 2023): approximately 40,000 EVs by 2028 (5-year horizon from autumn 2023).
- KazAvtoProm / market estimates (optimistic scenario, 2023–2024): 35–40,000 EVs by 2029.
- Estimates by charging station operators (private scenarios, 2024): ≈80,000 electric vehicles (including hybrids) by 2028 — market participant estimate (Qazaq Energe Charge) presented at an industry forum.

According to our analysis, early Kazakhstani forecasts missed actual outcomes due to the following root causes:

1. Incentive policies and the 2023–2024 roadmap: exemption of EVs from certain taxes and fees, non-financial incentives, and measures for charging infrastructure accelerated diffusion and enhanced the total cost of ownership (TCO) attractiveness.
2. Vehicle model availability and import orientation: rapid introduction of affordable Chinese brands led to a surge in registrations; 2023–2025 became a pivotal period.
3. Weak 2020–2022 baseline and linear extrapolation in early Ministry of Energy estimates: low initial levels resulted in underestimation of the S-curve growth.

Thus, most forecasts published before mid-2023 were systematically conservative; by 2025, the actual EV fleet had already exceeded these targets several times over. Later scenarios (MIA, KazAvtoProm, Satbayev University) better reflect the accelerated demand.

2. Materials and Methods

Early approaches to forecasting electric vehicle (EV) fleet growth relied on statistical methods (ARIMA, exponential smoothing, etc.), while classical diffusion models (e.g., logistic S-curve, Bass model) became widely applied later. As data accumulated and market dynamics grew more complex, focus shifted toward econometric models, machine learning, and neural networks [24].

Below, some forecasting models are considered in more detail:

ARIMA (Autoregressive Integrated Moving Average) is effective for short-term forecasts in stationary time series but does not account for external factors and poorly handles nonlinear growth typical of EV adoption.

- Advantages: suitable for short-term forecasts in stable EV markets; effective for linear and stationary processes.
- Limitations: requires series stationarity, ignores external factors, prone to underestimating forecasts during rapid growth phases.

Exponential Smoothing (ETS) is used in several forms (SES, Holt, Holt–Winters) and is suitable for regular and seasonal data, but struggles with abrupt structural shifts and requires stable trends.

- Advantages: simple to implement and interpret; accounts for trend and seasonality; suitable for short-term forecasts.
- Limitations: cannot handle nonlinear growth; poorly responds to sudden changes; requires regular time series.

Logistic Model is one of the simplest approaches for forecasting the adoption of new technologies. It describes gradual market saturation: growth rates are low at the initial stage, peak in the middle, and slow as saturation is approached. Functionally, it is defined by a small number of parameters (growth rate and market ceiling) and is symmetric around the inflection point. The logistic curve has been widely applied to innovation diffusion, including EV adoption, and is a convenient tool for long-term scenarios assuming smooth market development without sudden shocks [14].

- Advantages: conceptual and computational simplicity; parameters are intuitive (e.g., maximum EV fleet); minimal input data required.

- Limitations: forecast accuracy depends on market stage; may underestimate growth at early stages when influenced by external incentives (subsidies, infrastructure) or network effects; may overestimate growth at late stages if actual saturation is slower or asymmetric.

Bass Model is a classical diffusion model describing innovation adoption via two parameters: the innovation coefficient p (spontaneous first adopters) and the imitation coefficient q (followers influenced by prior adopters). The model generates an S-shaped cumulative adoption curve but, unlike the simple logistic model, is asymmetric and can reflect a slower start and rapid acceleration due to word-of-mouth effects. For EVs, the Bass model is used to forecast diffusion considering social propagation of information. Parameters p and q are calibrated using historical EV sales data.

- Advantages: simple structure; interpretable parameters (p – innovators' share, q – imitation strength); useful for early-stage qualitative analysis.
- Limitations: parameter estimation requires nonlinear optimization; does not explicitly account for external factors (prices, subsidies, infrastructure); regional calibration needed as p and q vary across countries due to culture, policy, and social factors. The model works best where adoption is primarily driven by social diffusion and policy measures.

Econometric Models explicitly account for factors influencing EV demand by establishing statistical relationships between EV numbers (sales or fleet) and explanatory variables. Multiple regression is commonly used, modeling sales as a function of income, fuel prices, electricity tariffs, number of charging stations, subsidies, etc. Each variable receives a coefficient estimated from historical data, indicating the strength of its impact.

- Advantages: interpretable; allows policy evaluation (e.g., effect of subsidy changes on sales).
- Limitations: requires long time series, careful factor selection, and reliable economic and infrastructure data; risk of overfitting or multicollinearity; linear regression may oversimplify inherently nonlinear relationships. Econometric models are useful for understanding causal mechanisms and evaluating country-specific scenarios but may be less accurate than purely mathematical or machine learning models during nonlinear growth phases.

Machine Learning (ML) Methods, particularly deep neural networks, are the most complex to implement. They require specialized knowledge and computational resources (GPU/TPU) for training.

Considering the early stage of EV market development in Kazakhstan and the incomplete statistical data, this study employed four models for scenario estimation:

- Exponential smoothing (Holt–Winters);
- Logistic model;
- Bass diffusion model;
- Third-degree polynomial regression.

Using a set of models allows capturing both inertial and innovative characteristics of EV diffusion and reduces the risk of over- or underestimating forecasted values.

3. Results and Discussion

In our view, at the current stage, government incentives in Kazakhstan should be focused on achieving the aforementioned share of electric vehicles (EVs) in new car sales at the level of 2.5%, i.e., approximately 10–15 thousand EVs per year.

We provide a forecast for the development of the EV fleet in Kazakhstan up to 2030 under three scenarios: pessimistic, realistic, and optimistic.

Globally, three main scenarios are considered for EV market development [16]:

- Inertial scenario (pessimistic): complete absence of support for transportation and infrastructure development.
- Balanced scenario (realistic): support for infrastructure and demand is maximized during the first three years of the project.
- Accelerated development scenario (optimistic): proactive infrastructure support, demand stimulation, and restrictions on internal combustion engine (ICE) vehicle use (this scenario is followed in Western Europe, the USA, and China).

Analysis of global EV fleet growth and sales trends shows that the EV fleet typically develops according to an exponential law over 10–15 years from market introduction (see Figure 8).

Considering significant discrepancies between forecasts and actual outcomes, as well as the fact that Kazakhstan is still in the "market emergence" stage (EV share in new car sales does not exceed 3%), a forecast for Kazakhstan's EV fleet is constructed using various models.

The optimistic forecast for Kazakhstan's EV fleet is based on general global trends. It is aligned with the promotion of the Electric Vehicle Initiative (EVI), adopted at the 2010 Ministerial Conference on Clean Energy (CEM). These initiatives are actively promoted by Canada, Chile, China, Finland, France, Germany, India, Japan, the Netherlands, New Zealand, Poland, Portugal, Sweden, the United Kingdom, and the USA [5].

It should be noted that Kazakhstan has incorporated the EVI initiative into its Strategy for Achieving Carbon Neutrality by 2060, which aims to reduce greenhouse gas emissions by 15–25% relative to 1990 levels by 2030 [17]. To achieve this goal, transportation is to be transitioned to alternative fuels (electricity, biofuels, hydrogen) with government support through infrastructure development and other incentive mechanisms.

Forecasting was performed using four models:

- Polynomial smoothing (third-degree polynomial regression);
- Exponential smoothing (Holt–Winters, additive trend);

- Bass diffusion model (parameters: potential market M≈109,000M, p≈0.000033p, q≈1.0);
- Logistic model (parameters: market capacity K≈99,300, growth rate r≈1.04, midpoint t_0≈2025).

To evaluate the accuracy of these models, we compared how well they describe actual data from 2015–2024. The following metrics were used:

- MAE (Mean Absolute Error): the lower, the better.
- RMSE (Root Mean Squared Error): sensitive to large deviations.
- R^2 (Coefficient of Determination): proportion of explained variance (1 – ideal).

A qualitative assessment of the applied models is presented in Table 3.

Table 3.
Comparative Assessment of Forecasting Models.

Model	MAE	RMSE	R^2	Assessment
Exponential Smoothing	1222	2318	0.688	Poor Fit
Bass Model	398	549	0.994	High Accuracy
Logistic Model	399	502	0.995	High Accuracy
Polynomial Model (3rd Degree)	626	844	0.959	Good Fit, but Risk of Overestimation

4. Analysis and Recommendations

Exponential Smoothing: underestimates the abrupt growth in 2023–2024 and is suitable only as a "lower bound" forecast.

Polynomial Model: approximates current data very well, but on a long-term horizon (after 2027), forecasts become overly optimistic. It is recommended only for short-term analysis.

Bass Model: accurately describes actual data (R^2=0.994), accounts for innovation effects and subsequent market saturation, and forecasts market saturation by 2030 at approximately 110,000 EVs.

Logistic Model: accuracy comparable to the Bass model (R^2=0.995), more conservative, predicts saturation at ~42,000 EVs, below actual trajectories; suitable as a "cautious forecast" scenario.

Key recommendations for selecting models to describe the EV fleet development scenario in Kazakhstan are summarized in Table 4:

1. For the main forecast of Kazakhstan's EV fleet, the Bass model is recommended, as it best reflects the dynamics of rapid growth and subsequent market saturation.
2. The Logistic model can be applied as a "conservative scenario."
3. The Polynomial model is useful for short-term forecasts (up to 5 years) but not for long-term projections.
4. Exponential smoothing can serve as the "lower bound" to estimate minimally expected growth rates.

This approach allows illustrating the range of possible trajectories—from pessimistic/conservative (~40,000 by 2030) to optimistic (~120,000 by 2030), with a realistic/base scenario (~110,000) (see Table 4 and Figure 9).

Table 4.
EV Fleet Development Scenarios in Kazakhstan up to 2030.

Year	Pessimistic (Logistic Model)	Realistic Scenario (Bass Model)	Optimistic (Polynomial Model)	Lower Bound (Exponential Smoothing)
2025	~34 700	~46 600	~21 600	~16 700
2026	~39 900	~74 300	~33 500	~20 700
2027	~41 500	~94 900	~48 900	~24 800
2028	~42 000	~105 800	~68 300	~28 800
2029	~42 100	~110 400	~92 000	~32 800
2030	~42 100	~112 300	~120 600	~36 900

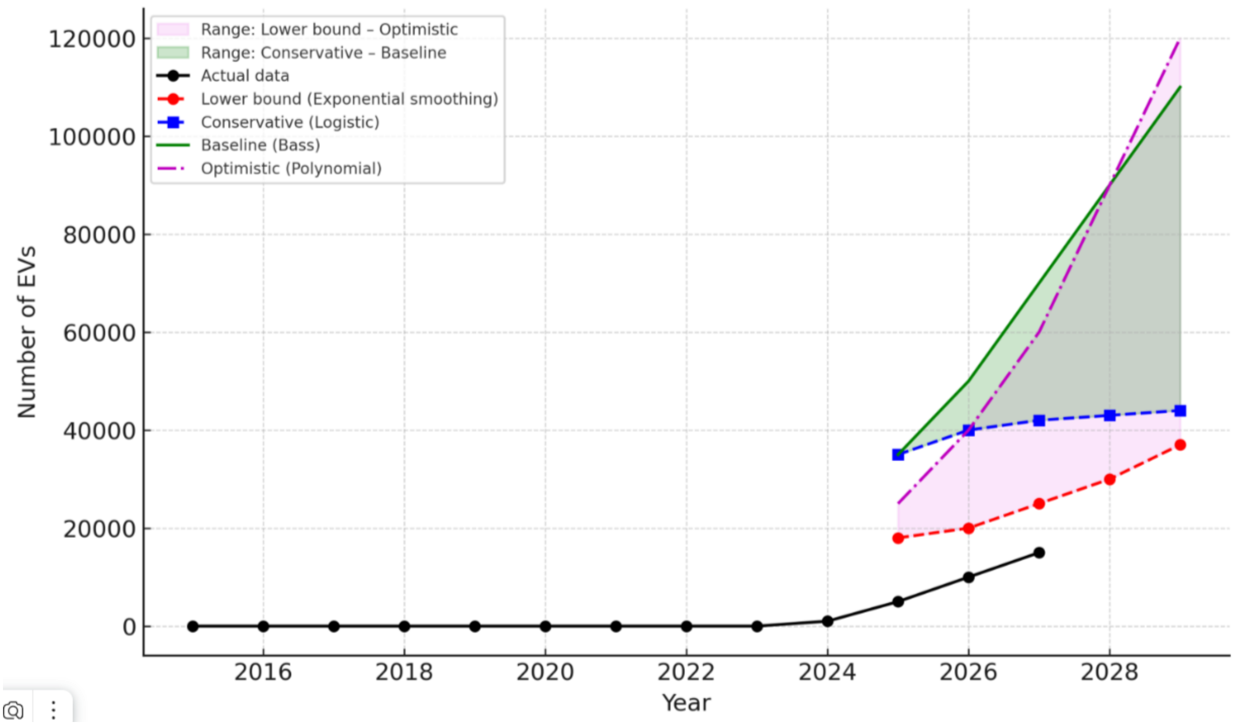


Figure 9.
Scenario Forecast of the EV Fleet in Kazakhstan (2025–2030), with the purple area representing the range between the lower bound and the optimistic scenario, and the green area representing the range between the conservative and baseline scenarios.

Based on the calculations, the range of EV fleet development scenarios in Kazakhstan up to 2030 has been determined [24]:

- Pessimistic/conservative scenario (Logistic Model): ~42,000 EVs;
- Realistic/baseline scenario (Bass Model): ~112,000 EVs;
- Optimistic scenario (Polynomial Model): ~120,000 EVs;
- Lower bound (Exponential Smoothing): ~37,000 EVs.

The average forecast is approximately 78,000 EVs by 2030.
Key conditions for realizing these forecast scenarios include:

- Expansion of the charging infrastructure: by mid-2024, there were approximately 269 charging stations, with more than half concentrated in Astana and Almaty;
- Removal of regulatory and institutional barriers: absence of a comprehensive EV law, non-unified technical standards for connecting charging stations, and insufficient mechanisms to support investors;
- Development of incentive measures: customs and tax benefits, exemption from recycling fees, free parking, and access to dedicated lanes.

Analysis of the EV fleet development in Kazakhstan over 2012–2025 indicates that the market is at an early growth stage. Despite significant annual growth rates (50–80%), absolute figures remain low: EVs account for less than 1% of the total vehicle fleet and under 2% of new vehicle sales. The primary growth comes from passenger cars, while truck and bus segments show moderate but positive trends.

A critical limiting factor is the underdeveloped charging infrastructure. With the projected growth of the EV fleet by 2030, ensuring adequate coverage (10–20 EVs per charging station) will require a multiple increase in the number of charging stations, up to 4,000–8,000 units, making infrastructure deficits a key barrier to further market expansion.

Other challenges include the high cost of EVs, limited consumer and manufacturer incentives, dependence on imported vehicles and equipment, and the lack of a comprehensive regulatory and technical framework, including standards for installing charging stations in parking lots and residential complexes.

To overcome these barriers, a systemic approach is required, including:

1. Scaling up charging infrastructure based on a national program, targeting both highway and urban networks;
2. Expanding government support measures (tax benefits, subsidies, preferential auto loans) and introducing non-financial incentives (free parking, dedicated lanes, benefits in public procurement);
3. Developing a regulatory and technical framework harmonized with international standards, including requirements for equipment at parking facilities;
4. Promoting localization of production and service networks to reduce import dependence and ensure service accessibility;
5. Evaluating the environmental and social impacts of EV adoption and integrating these results into national sustainable development programs.

Comparison with global trends (EU, USA, China) shows that Kazakhstan lags in EV adoption but has significant potential due to low electricity tariffs, growing private-sector interest, and plans for expanding charging infrastructure. With consistent government support and investment incentives, the country could transition from the "market emergence" stage to sustainable growth within the next 5–7 years.

Thus, Kazakhstan faces a strategic choice: either maintain gradual growth based on current trends or pursue an accelerated development scenario informed by international experience and comprehensive support measures. Implementing the latter scenario could make EVs a key component of the country's transport system by 2030.

5. Conclusions

This study was conducted within the framework of the targeted funding agreement for the project *"Analysis of the EV Fleet in Kazakhstan and Development of Measures for Urban Electric Transport Infrastructure, including an Assessment of Prospects for Autonomous Routes"*, concluded between the Corporate Fund KAZLOGISTICS and Satbayev University.
Based on the analysis of the current global electric vehicle market, the following conclusions can be drawn:

1. The global EV market demonstrates accelerated growth, confirming the transition to the mass adoption stage of transport electrification.
2. BEVs maintain a leading position due to decreasing battery costs, infrastructure development, and zero-emission policies, while PHEVs serve as an intermediate solution.
3. The global EV market exhibits regional asymmetry: growth in China significantly outpaces Europe and the USA, while the share of other countries remains limited.
4. China's leadership is driven by a combination of factors, including substantial subsidies, a strong charging infrastructure, and active import-substitution policies. Europe and the USA form the second tier of leaders, while emerging markets currently play a marginal role.
5. By 2030, the EV market in Kazakhstan is expected to develop within a range of 37,000 to 120,000 units.
6. The most probable scenario is the realistic/baseline scenario (~112,000 units), which aligns with global trends toward low-carbon transport.
7. Achieving the optimistic scenario is feasible with large-scale deployment of charging infrastructure, comprehensive government support, and increased consumer confidence.

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