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CHINA'S GOVERNMENT PROGRAMS SUPPORTING ELECTRIC VEHICLE PRODUCTION: IMPACT ON SECTOR DEVELOPMENT AND GLOBAL TRENDS IN SUSTAINABLE TRANSPORTATION

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Abstract. *The purpose* of this article is to substantiate the necessity of government programs in the People's Republic of China (PRC) in supporting electric vehicle (EV) production, analyze the impact of these initiatives on the growth and development of the EV sector, and their contribution to the global transition to sustainable transportation. The article aims to provide both theoretical insights and scientific and practical recommendations for enhancing the effectiveness of public policies and financial incentives to accelerate EV production, reduce carbon emissions, promote green innovation in the automotive sector, and develop infrastructure and research support provided by the Chinese government. *Methodology.* The article uses a combination of quantitative and qualitative research methods to analyze the impact of government programs on EV production in the PRC. Statistical analysis is applied to assess the relationship between government incentives (such as subsidies, tax breaks, and grants) and the growth of EV production in the PRC. A case study approach is also used to examine successful government initiatives in the PRC. Additionally, comparative analysis is employed to explore the effectiveness of different policy models and identify challenges and opportunities for scaling up EV production in the PRC. *The results* of the study show that government programs play a crucial role in stimulating the growth of EV production in the PRC. Support from the Chinese government for the EV market through financial subsidies, tax incentives, and investments in infrastructure has successfully positioned the PRC as a global leader in the EV market. Despite these achievements, challenges remain in rural adoption and technological integration, which require continued innovation and policy refinement. The study also identifies several issues, including high initial costs, limited charging infrastructure, and resistance from traditional automakers. *Practical implications.* The study's findings underline the need for governments to design policies that combine financial incentives, infrastructure development, and regulatory measures to support the EV industry. We have developed and proposed practical recommendations to enhance the effectiveness of government programs, such as the integration of public-private partnerships, the development of targeted incentives for manufacturers, and the creation of EV production hubs. These measures are essential to overcoming existing barriers and achieving large-scale EV adoption. *Value / Originality.* This article provides an in-depth analysis of government programs supporting EV production, contributing to existing knowledge by offering new ideas for improving public policy to accelerate the green transition in the automotive sector and the long-term sustainability of China's EV programs. The research contributes to the understanding of effective tools and strategies for boosting EV production and adoption, emphasizing the need to shift from subsidies to fostering innovation and addressing the challenges of rural adoption and infrastructure development. The study's findings are relevant for policymakers, stakeholders, and researchers in the field of electric vehicle production and consumption in the PRC and worldwide, particularly in the context of sustainable development and environmental transformation.

Keywords: government programs, state regulation of electric vehicle production, sustainable transportation promotion policy, environmental transformation of transportation, effectiveness of financial mechanisms of government support, government support in achieving carbon neutrality.

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1. Introduction

The rapid transition to electric vehicles (EVs) has emerged as a central component of global strategies to mitigate climate change, reduce urban air pollution, and achieve sustainability targets. In this context, the People's Republic of China (PRC), as both the world's largest automotive market and a leading emitter of greenhouse gases, plays a critical role in the development of electric mobility. In response to the growing environmental challenges and in alignment with its long-term goals for carbon neutrality, the Chinese government has implemented a series of policies aimed at accelerating the transition to electric transportation.

With the ambitious target of achieving peak carbon emissions by 2030 and carbon neutrality by 2060, China's EV strategy is expected to evolve significantly over the next decade. The government has laid out specific goals to increase the share of new energy vehicles (NEVs) in the domestic vehicle market, as well as to advance the integration of EVs with smart grids, autonomous driving technologies, and renewable energy sources (H. Ren, Z. Liu, 2024). Despite the impressive growth of the sector, significant challenges remain, including regional disparities in infrastructure, the gradual phase-out of subsidies, and the need for continued technological advancements to ensure the economic viability of EVs in the long term.

Research on China's government programs for the development of EV production primarily focuses on policies aimed at incentivizing both the supply side (manufacturers) and demand side (consumers). Ehsan F. et al. (2024) discuss the evolution of the Chinese EV industry in light of state-backed incentives such as subsidies, tax exemptions, and purchase incentives. According to the authors, the government's role in promoting electric vehicles has been essential to the rapid expansion of EV infrastructure and the technology's widespread adoption (Shan J., 2024). A significant policy in the Chinese EV sector is the "New Energy Vehicle (NEV) policy", which includes various subsidy schemes, like the ones introduced in the 13th Five-Year Plan (2016-2020) (Sun Y. et al., 2022).

One of the primary aspects of China's approach to EVs is the development of charging infrastructure. Research by Rajendran G. et al. (2021) explores the government's policies for promoting electric vehicle charging stations and battery swapping stations. According to these studies, the Chinese government has made substantial investments in EV infrastructure, especially in metropolitan areas such as Beijing, Shanghai, and Shenzhen. However, as noted by Zhang W. et al. (2022), the PRC still faces challenges related to the uneven distribution of charging infrastructure, particularly in smaller cities and rural regions, which may hinder the adoption of EVs.

Additionally, scholars like Boonseng T. et al. (2021) highlight the development of Vehicle-to-Grid (V2G) technologies, which are part of China's broader strategy to integrate electric vehicles with the national grid. These innovations are central to making EVs a more viable option by enhancing energy storage capacity and supporting the renewable energy transition.

European scholars have provided an external perspective on China's EV development. Kene R. et al. (2021) examine the European Union's approach to electric mobility and its comparison with China's strategies. They note that China's aggressive policy support and state investment in EV production and infrastructure outpace European efforts, with the European Union having a more fragmented approach to EV promotion.

A similar perspective is offered by European researchers, who argue that while European countries like Norway, Germany, and France have strong EV initiatives, China's centralized decision-making processes enable faster and more extensive infrastructure rollout. The authors suggest that Europe should look to China's model, particularly in terms of battery manufacturing and rapid infrastructure development, to achieve its own EV goals by 2030.

Several studies focus on the environmental and economic aspects of China's technological leadership. The scholars Dovgal O., Goncharenko N. et al. (2019, 2020, 2021) arguing that the PRC, thanks to comprehensive government support and investments in sustainable technologies, is currently shaping new standards that influence environmental practices in other countries. This positions the PRC at the forefront of the global transformation of transportation and sustainable development.

While much has been written about the rapid development of electric vehicle production in the PRC, there is a noticeable gap in research

regarding the long-term sustainability of these programs post-subsidy phase that determines the relevance and necessity for further work in this direction.

This article seeks to examine the government's programs and initiatives for the future development of electric vehicle production and infrastructure in the PRC, with a focus on the period from 2025 to 2030. The study aims to assess the effectiveness of these policies in achieving the country's environmental and economic goals, while also identifying the challenges and gaps that need to be addressed to ensure the sustainable growth of the EV sector. By analyzing existing research, policies, and ongoing initiatives, this article provides insights into the evolving landscape of electric mobility in the PRC, while offering a critical evaluation of the underlying factors influencing the sector's future trajectory.

The purpose of this article is to substantiate the necessity of government programs in the People's Republic of China in supporting electric vehicle production, analyze the impact of these initiatives on the growth and development of the EV sector, and their contribution to the global transition to sustainable transportation. The article aims to provide both theoretical insights and scientific and practical recommendations for enhancing the effectiveness of public policies and financial incentives to accelerate EV production, reduce carbon emissions, promote green innovation in the automotive sector, and develop infrastructure and research support provided by the Chinese government.

2. Governmental Policies and Initiatives in the PRC

A significant incentive for intensifying efforts to change China's energy balance structure has been the country's desire to express solidarity with the global community in achieving global environmental security. The "Made in China 2025" plan, announced by the State Council of the People's Republic of China (China State Council, 2024), sets as its main goal the transformation of the PRC into a modern innovative power, with the development of strategic industries featuring advanced high-tech developments, including the production of vehicles using alternative energy sources, as the means to achieve this goal.

Since 2009, the PRC has been implementing comprehensive government programs to support the production and consumption of electric vehicles. These measures are aimed at stimulating industry development, reducing environmental pollution, and strengthening China's position in the global electric vehicle market.

Based on an analysis of China's government policy and government programs for the development of EV production and consumption, we have identified the main government support measures:

– Subsidies for Electric Vehicle Purchases: Buyers of fully electric vehicles can receive subsidies of up to 60,000 yuan, while the subsidy for plug-in hybrid electric vehicles (PHEVs) is up to 50,000 yuan (National Development and Reform Commission of China, 2024).

– Tax Benefits: Exemption from value-added tax on the sale of electric vehicles; reduction of corporate income tax for EV manufacturers; exemption from dividend tax for companies involved in electric vehicle production.

– Government Funding for Infrastructure: Investments in the construction of charging stations and the development of EV servicing networks; subsidies for the installation of home charging devices for electric vehicle owners.

– Government Procurement: Priority purchases of electric vehicles for government needs, including vehicles for state institutions and public services.

– Research and Development (R&D): Funding for research and development in battery technologies, control systems, and other components of electric vehicles.

– Export Subsidies: The Chinese government provides subsidies and tax breaks to Chinese electric vehicle manufacturers to stimulate exports.

3. Government Programs Supporting Electric Vehicle Production in the PRC

The financial volumes of sales and government programs supporting the production of electric vehicles in the PRC are an essential part of the development of the sustainable transport sector in the country. In recent decades, the Chinese government has actively invested in this industry, which has resulted in an increase in the production and sales of electric vehicles. These measures include various subsidies, tax incentives, and other forms of financial support.

An analysis of government support programs and related financial volumes helps assess the scale of state aid within the implementation of the "green economy" strategy (China State Council, 2024):

1. Electric Vehicle Purchase Subsidy Program: Subsidy programs have been in effect since 2009, and the government significantly expanded them in 2015. Under this program, the PRC provides subsidies for the purchase of electric and hybrid vehicles. These include: 1. Subsidies for Electric Vehicles: The maximum subsidy for fully electric vehicles was up to 60,000 yuan. This program aims to stimulate demand among consumers and promote the transition to environmentally friendly transport. 2. Subsidies for Hybrid Electric Vehicles (HEVs): For hybrid vehicles, the subsidy can reach 50,000 yuan, depending on the size of the battery and other factors.

2. "Tenth Plan for the Development of Electric Vehicles" (2021-2025): This program aims to support manufacturers and the development of new technologies. It includes several directions, such as: 1. Allocating 130 billion yuan to support electric vehicle manufacturers, including subsidies for the purchase of new models. 2. Financing the creation of charging infrastructure for electric vehicles, including the construction of new charging stations in cities and at fuel stations.

3. Government Subsidies for Research and Development: the PRC also invests significant funds in research and development for new electric vehicle technologies. The primary focus is on improving battery technologies and increasing energy efficiency. In 2022, the Chinese government allocated 10 billion yuan for supporting research projects in electric vehicle technologies, batteries, and charging infrastructure.

According to data from the Center for Strategic and International Studies (CSIS), from 2009 to 2023, Chinese authorities spent approximately 230.9 billion USD on the development of the electric vehicle industry. The majority of these funds were directed toward financing subsidies for consumers, as well as developing charging infrastructure, tax incentives, and subsidies for infrastructure, R&D expenses, and government procurement.

For example, in 2022, the subsidy volume for purchasing electric vehicles amounted to about 26 billion USD, and 14 billion USD was allocated for creating charging infrastructure. As a result of these financial investments, China became a leader in the global electric vehicle market, with sales exceeding 6.9 million vehicles in 2023, accounting for approximately 60% of global electric vehicle sales (Xinhua News, 2024). The growing demand for electric vehicles in the PRC, supported by financial and infrastructure measures, has strengthened the country's position in the global automotive industry.

Thanks to these measures, the PRC became the largest electric vehicle market in the world. In the first half of 2024, the sales of fully electric and hybrid models in the PRC accounted for 65% of the global total (China Association of Automobile Manufacturers, 2024).

The PRC continues to actively develop the electric vehicle sector, introducing new programs and initiatives aimed at stimulating production, consumption, and infrastructure development for electric vehicle transport.

1. Extension of Tax Benefits for Electric Vehicle Buyers: In 2024 and 2025, the Chinese government extended the tax exemption on the purchase of electric vehicles, plug-in hybrids, and hydrogen-powered vehicles. This decision aims to reduce the purchase cost and stimulate demand for environmentally friendly vehicles.

2. "Made in China 2025" Program: As part of the "Made in China 2025" initiative, the Chinese government aims to position the country as a global leader in the production of high-tech products, including electric vehicles. The program includes significant investments in scientific research, new technologies, and modernization of production capacities.

3. Development of Charging Station Infrastructure: the PRC plans to equip at least 60% of all express highways with fast-charging stations and 80% of regions with high levels of air pollution by the end of 2025 (China National Energy Administration, 2024). This will significantly improve the accessibility and convenience of electric vehicles for consumers.

4. Electrification of Public Transport: By the end of 2025, the PRC aims to convert up to 80% of urban buses and taxis to electric engines. This measure is aimed at reducing carbon dioxide emissions and improving air quality in cities.

5. Stimulating Electric Vehicle Sales: In 2025, Chinese electric vehicle manufacturers, such as Nio and Li Auto, will continue to offer various incentives to buyers, including cash subsidies and interest-free credit programs. These measures aim

to sustain demand and stimulate sales growth in a competitive market. It is expected that in 2025, electric vehicle sales in the PRC will grow by 20%, reaching 12 million units. This is more than double the sales volume of 2022 and reflects the rapid growth of the electric vehicle market in the country.

6. "Tenth Plan for the Development of Electric Vehicles" (2021-2025): Under this program, the PRC allocates 130 billion yuan to support electric vehicle manufacturers, including subsidies for the purchase of new models and financing the creation of charging infrastructure for electric vehicles.

4. Recommendations for Improving Government Policy of the Electric Vehicle Market Development

The PRC continues to actively develop and implement programs to support the production and consumption of electric vehicles for the period from 2025 to 2030. These initiatives are aimed at achieving ambitious environmental and economic goals, including reducing carbon dioxide emissions and developing high-tech industries.

1. Legislative Initiatives and Goals: On January 1, 2025, the PRC enacted its first-ever energy law, aimed at promoting carbon neutrality. This document establishes the legal foundations for transitioning to renewable energy sources and improving energy efficiency, including support for the electric vehicle sector.

By 2030, the PRC plans for new electric vehicles to account for 40% of all vehicles on the roads. This ambitious goal is aimed at significantly reducing carbon dioxide emissions and improving air quality.

2. Infrastructure and Technology Development: By the end of 2025, more than 50 large pilot V2G (Vehicle-to-Grid) projects are planned in regions with developed infrastructure, such as the Yangtze River Delta, Pearl River Delta, Beijing, Tianjin, Hebei, Shandong, Sichuan, and Chongqing. These projects are aimed at integrating electric vehicles into energy grids, enabling the use of their batteries for energy storage and transfer.

By the end of 2025, the PRC plans to ensure that fast-charging stations cover at least 60% of all express highways and 80% of regions with high air pollution levels. This will significantly improve the accessibility and convenience of using electric vehicles for consumers.

3. Economic Measures and Production Stimulus: the PRC will continue providing subsidies for the purchase of electric vehicles and hybrid vehicles, as well as tax benefits for manufacturers and consumers. However, starting in 2023, the government will gradually reduce the size of subsidies, encouraging manufacturers and consumers to transition more actively to electric vehicles without government support.

It is expected that by the end of 2025, electric vehicle sales in the PRC will grow by 20%, reaching 12 million units. This will be more than double the sales volume of 2022 and signals rapid growth in the country's electric vehicle market.

By 2030, the PRC plans for new electric vehicles to make up 40% of all vehicles on the roads, aiming for a significant reduction in carbon dioxide emissions and improved air quality (Zhang Z. et al., 2022).

Thus, the PRC continues to invest actively in the development of the electric vehicle sector, combining legislative initiatives, infrastructure development, economic measures, and scientific research to achieve the set goals for sustainable transportation.

However, despite the comprehensive and well-thought-out nature of the state support for the electric vehicle manufacturing sector in the PRC, there remain significant gaps that highlight the need for the development of scientifically grounded, practical recommendations aimed at refining state policies designed to foster the growth of the electric vehicle production market in the PRC.

The rapid development of China's electric vehicle market has been primarily driven by strong government support through various incentives and policies. However, as the market matures, there is a need to refine and adapt these policies to ensure sustainable long-term growth and the achievement of national goals related to carbon neutrality and energy transition. The following recommendations focus on enhancing government policy and fostering the development of the EV market in the PRC:

1. Gradual Phasing Out of Subsidies with Enhanced Focus on Innovation

While subsidies have been pivotal in stimulating the initial growth of the EV market, their gradual phase-out has become inevitable as part of China's economic transition towards a more market-driven model. It is crucial that the Chinese

government shift subsidies towards innovation. Instead of blanket subsidies for EV purchases, focus on supporting innovation in key technological areas such as battery production, energy density, autonomous driving, and vehicle-to-grid (V2G) technologies. Providing financial incentives to research and development will enhance the global competitiveness of Chinese EV manufacturers and attract investment in next-generation technologies.

It is necessary also to provide targeted financial support to emerging EV manufacturers and local suppliers of critical raw materials, particularly lithium, cobalt, and nickel, to reduce supply chain risks and foster greater supply chain autonomy.

By focusing on R&D and technological innovation, China can maintain a competitive edge in the global EV market and accelerate the transition to EVs even after subsidies are phased out.

2. Expansion of Charging Infrastructure in Rural and Underserved Areas

Despite the rapid growth of EV charging infrastructure in China's large cities, rural and smaller urban areas still face significant infrastructure gaps, limiting EV adoption. The government should consider the targeted infrastructure investment and design policies that promote the installation of charging stations in underserved regions, focusing on economically disadvantaged areas and smaller towns. This could involve offering incentives for private companies to build and operate charging networks outside major metropolitan centers, addressing regional disparities. Standardization of charging networks is also important. It will increase consumer confidence and encourage EV adoption by reducing concerns over charging access and convenience.

3. Promoting EV Battery Recycling and Sustainable Practices

The long-term sustainability of the electric vehicle market depends on ensuring that battery production and disposal are environmentally responsible. The Chinese government can improve the environmental sustainability of the EV sector by supporting battery recycling technologies and providing funding and incentives for the development of efficient EV battery recycling technologies to reduce environmental impact and dependence on raw material imports. By incentivizing closed-loop recycling systems, the PRC could lead the world in sustainable battery production.

It is necessary also to pay attention on the creating a regulatory framework for end-of-life vehicle (ELV) disposal. Implementation of regulations for the responsible disposal and recycling of EV batteries and vehicle components will ensure that the PRC can minimize the environmental impact of retiring electric vehicles as the market matures.

4. Integration of EVs into National Smart Grid Systems

As China continues to expand its renewable energy capacity, the role of electric vehicles in balancing grid demand and integrating renewable energy sources becomes more critical. To facilitate this, the government should encourage vehicle-to-grid (V2G) integration and develop policies to support the integration of electric vehicles into smart grid systems, allowing them to serve as mobile energy storage devices. The government should invest in the necessary infrastructure and provide incentives for both consumers and manufacturers to adopt V2G technologies.

The government should facilitate cross-sector collaboration and encourage collaboration between the electric vehicle sector, the renewable energy sector, and utility providers to create a robust ecosystem where EVs can complement renewable energy sources and optimize grid management. Policies should incentivize investments in smart grids, demand-response systems, and dynamic pricing models.

5. Enhancing International Collaboration and Trade Policies

Given China's dominance in the global EV market, strengthening international cooperation and trade policies is essential for sustaining market leadership. The government should foster international collaborations, promote joint ventures, technology exchange programs, and research collaborations with leading global EV manufacturers, tech companies, and academic institutions. These partnerships could advance EV innovation, manufacturing capabilities, and infrastructure development.

The government should also develop supportive trade policies; encourage the export of Chinese-made EVs and batteries by establishing

favorable trade agreements and reducing trade barriers.

5. Long-Term Sustainability through a Holistic Policy Approach

Finally, the PRC should adopt a more holistic approach to EV development that integrates various aspects of policy and practice. At-first, the government should ensure that policies related to EV development, renewable energy, urban planning, transportation, and environmental protection are aligned to create a unified strategy that supports long-term sustainability. The government should also work to remove bureaucratic barriers between departments and levels of government to streamline policy implementation. Second, they should provide data-driven policy adjustments: implement a robust system for tracking the progress of EV adoption, including monitoring consumer behavior, infrastructure development, and environmental impacts. Use this data to continuously adjust policies and provide targeted interventions as necessary.

5. Conclusions

Thus, the state programs of the People's Republic of China supporting electric vehicle production represent a comprehensive strategy, including financial incentives, tax benefits, infrastructure development, and support for R&D, which have contributed to the significant growth of the Chinese electric vehicle industry.

The PRC continues to actively invest in the development of the electric vehicle sector, combining financial incentives, infrastructure development, and research support to achieve its goals in sustainable transportation.

It is predicted that by 2030, the volume of electric vehicle sales in the PRC may reach 30 million vehicles per year, which will require further increases in government investments in the sector. This includes both direct subsidies and financial support for research and development in battery technologies and the development of infrastructure for electric vehicle charging.

Therefore, China's financial support programs ensure stable growth in both the production and consumption of electric vehicles, making this sector strategically important for the country's economy.

However, despite these successes, there are notable challenges, particularly in rural areas, where EV adoption has been slower due to infrastructure gaps, limited consumer awareness, and lower incomes.

The government's strategy of gradually phasing out subsidies and refocusing efforts on technological innovation, research and development, and market-driven policies is crucial for the long-term sustainability of the sector. Fostering technological advancements in battery technology, energy efficiency, and vehicle-to-grid integration will be key to maintaining China's competitive edge in the global market. Additionally, increasing investments in infrastructure, particularly in underserved rural areas, will be vital for achieving widespread adoption and realizing the country's carbon neutrality goals.

The research underscores the need for continued international cooperation and cross-border collaborations to drive innovation and expand market opportunities. Strengthening trade policies, promoting joint ventures, and ensuring harmonized regulatory frameworks across borders will facilitate China's global leadership in the EV sector.

In conclusion, while China's electric vehicle policies have been highly successful in driving growth, it is essential to focus on innovation, rural adoption, and sustainable practices to ensure that the country's position in the global EV market remains strong and resilient. These efforts will contribute not only to achieving China's environmental goals but also to setting a global standard for the development and integration of electric vehicles into the broader energy systems.

The development of the electric vehicle market in the PRC presents a unique opportunity to drive sustainable economic growth, reduce carbon emissions, and reshape global transportation systems. By refining existing policies, addressing regional disparities in infrastructure, encouraging technological innovation, and promoting international cooperation, the PRC can further solidify its position as a global leader in electric mobility. However, a carefully balanced approach that fosters market-driven growth while ensuring the long-term sustainability of the EV ecosystem is essential to meeting the country's ambitious carbon neutrality targets by 2060.

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