The Role of the Electric Vehicle Industry in Advancing Green Economic Growth

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Abstract. Global carbon emissions have increased notably over the past decade, leading to environmental issues such as climate change. The electric vehicle (EV) industry has emerged as a sustainable solution to the environment. This paper examines the crucial role of the EV industry in promoting green economic growth. It explores the green attributes of the EV industry, including its potential for zero carbon emissions. It introduces the green economic development theory and its factors, such as technological innovations, policy support, and corporate social responsibility (CSR). Then, the paper analyzes EV-driven pathways to green economic growth from aspects like energy structure transformation, green industrial chains, circular economy, and technological innovation. The findings suggest that EVs play a significant role in green economy development. This has a positive impact on green economy. To maximize the positive impacts of EVs on green economic growth, it is vital to have comprehensive policy support, efficient resource utilization, and technological innovation.

Keywords: Electric Vehicle Industry; Green Economic Growth; Mechanism Analysis

1 Introduction

In recent years, environmental issues such as climate change and rising carbon emissions have received increasing attention. In 2024, the global average annual temperature was approximately 1.47 °C higher than pre-industrial levels, marking the warmest year on record. In the same year, global carbon dioxide emissions reached a record of 3.78 billion tons. According to the latest data, 2015 to 2024 was the hottest decade on record.

The transportation sector in China account for about 10.4% of its total carbon emissions [1]. Therefore, it is crucial to implement active carbon emission reduction measures [2]. Against this backdrop, EVs, which use environmentally friendly energy such as electricity and hydrogen as their driving force, have been widely promoted for their low pollution or zero pollution advantages and are regarded as a new trend in the future development of the automotive industry. In the past five years, the global EV market has shown a rapid growth trend. Fig.1 clearly demonstrates the rapid global

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acceleration in the adoption of EVs, with all three major markets exhibiting a strong upward trajectory.

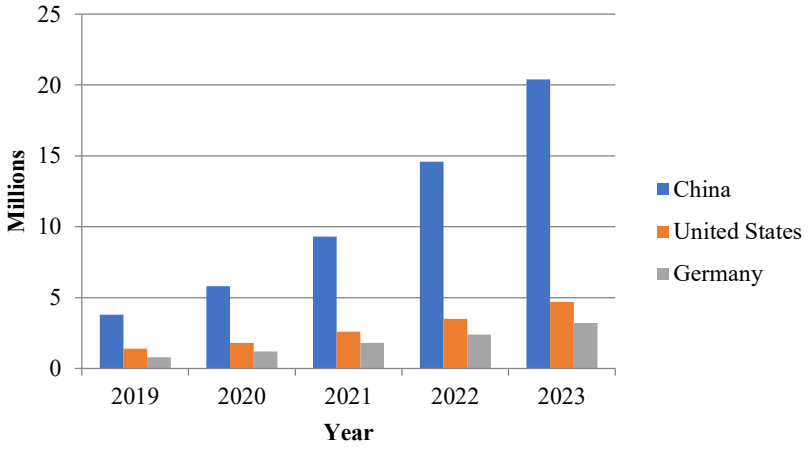

Fig. 1. The rising trend of New Energy Vehicle stock for the world's top three countries from 2019 to 2023

Beyond the environmental benefits, EV industry promotes renewable integration, fosters green supply chain development, advances circular economy, and boosts technological innovation. These attributes position the EV industry not merely as a environmental protection solution but also as a catalyst for broader economic and ecological transformation. The EV sector provides critical insights for policymakers and industry stakeholders to design their incentives and regulatory frameworks, eventually maximizing the socio-environmental and economic impacts of EV adoption.

2 Theoretical Foundation

2.1 Green Attributes of the EV Industry

The EV industry has essential green attributes. EVs lead to emission reduction and environmental protection by replacing gasoline-powered vehicles. They can achieve near-zero or even zero carbon emissions, aligning with global climate goals. In addition, they reduce dependence on imported oil and mitigate risks associated with foreign energy constraints. Beyond transportation, the EV industry also promotes technological innovations in battery recycling, energy storage, and green manufacturing. These innovations would accelerate sustainable development and ecological transformation.

A defining green attribute of EVs is their potential for zero carbon emissions. Most scholars believe that EVs can significantly reduce air pollutant emissions compared to traditional fuel vehicles. Research indicates that EVs will accelerate the transformation of the global energy and automotive industries, which would further promote emission reduction and environmental protection efforts in the transportation sector. In China,

the promotion of EVs reduces urban carbon emissions by adjusting the energy mix; for every 1% increase in EV sales, urban carbon emissions decrease by 0.096% [3]. Some scholars predict that the carbon emission reduction rate of EVs will reach 19.32% by 2035. Moreover, the EV industry play a vital role in promoting sustainable energy development. By shifting demand from fossil fuels to electricity, they create strong incentives for the expansion of renewable energy. This integration enhances energy use efficiency and accelerates the modernization of power grids and the deployment of smart charging infrastructure, further supporting sustainable development.

2.2 Green Economic Development Theory

The notion of a "Green Economy" has gained increasing prominence since the 2008 global financial crisis. There are four major impacts of a green economy: the input effect, which enlarges production resources; the efficiency effect, which enhances productivity toward the frontier; the stimulus effect, which boosts the economy during crises; and the innovation effect, which fosters faster technological progress and adoption. The green economic development theory is a theoretical framework that pursues environmental protection, resource conservation, and social sustainability in the process of economic development.

Firstly, technological progress plays a vital role in the development of a green economy. Green finance, as a crucial segment of green economy, faces challenges such as green project risk management, a lack of innovative financial products, and regulatory compliance. Emerging technologies such as blockchain, artificial intelligence, machine learning, data analytics, the Internet of Things, and robotics are addressing these challenges [4]. For example, AI- and ML-driven data approaches enhance risk assessment, while FinTech-based crowdfunding platforms and regulatory technology (RegTech) promote innovation and compliance. Green credit, green bonds, and green insurance are supporting the green economy, such as in the new energy vehicle industry. Specifically, green credit streamlines processes and subsidizes R&D; green bonds expand financing capacity and enhance corporate resilience; and green insurance reduces risks for small and medium-sized enterprises [5]. These mechanisms collectively provide essential funding and risk sharing, promote technological innovation and industrial collaboration, and ultimately accelerate the transition to a low-carbon, green economy aligned with the dual carbon goals.

Policy support and regulation are indispensable. Governments can encourage sustainable practices through carbon pricing, tax incentives, and stricter emission standards. Effective governance thus creates an enabling environment for sustainable economic transformation. For instance, China has prioritized the development of a carbon emissions trading market, with the power generation industry selected as the first sector to implement the national carbon emissions trading market policy. Researches show that pilot carbon emissions trading market policy can effectively reduce the operating hours of high-emission units, particularly thermal power plants, and promote an increase in the proportion of renewable energy generation [6]. Moreover, according to Opinions on Promoting Green and Low-Carbon Transformation and Strengthening the Construction of the National Carbon Market (2025), in 2027, the carbon trading market

would basically cover the major high-emission industries in the industrial sector, aiming for a unified national carbon market by 2030.

The changes in the modern world also require organizations practicing corporate social responsibility (CSR) to adopt more innovative approaches. The rapid growth and widespread adoption of effective CSR practices in services have become a standard of the green economy [7]. This not only reflects a shift but also represents a key area for further green economy development. Businesses, in building and implementing new CSR strategies, are exploring new opportunities while addressing pressing socio-environmental issues [8]. The fast-evolving business environment encourages interdisciplinary discussions about new areas of organizational activity [9]. A new direction in CSR development, focused on "green jobs," is emerging, which increases collaboration with stakeholders and environmental protection. Also, the adoption of circular economy principles helps industries reduce waste while maintaining competitiveness.

3 EV-Driven Pathways to Green Economic Growth

A green economy aims to achieve harmonious unity between economic growth, environmental protection, and sustainable resource utilization. EVs are the key engine and core pillar driving the transformation to a green economy. They represent not only a shift in the power source for transportation but also a profound revolution in energy, the environment, technology, and industry, exerting far-reaching and positive impacts across multiple dimensions of the green economy.

3.1 Promoting Energy Structure Transformation

The EV industry is crucial for transforming the energy structure by shifting transportation from heavy reliance on imported oil to domestically produced electricity, particularly from renewable sources. This transition not only enhances national energy security but also integrates renewable energy with the grid. Vehicle-to-grid technology makes EVs mobile distributed storage units. They can charge during times when the demand is relatively lower, for example at windy night. They can also feed electricity back into the grid during periods of higher demand. In this way, EVs help stabilize the renewable energy power generation, mitigate the problem of curtailed wind and solar power, and accelerate the development of green energy systems.

3.2 Driving the Development of Green Industrial Chains

The green supply chain drives the development of green mining and recycling technologies upstream by increasing demand for key battery minerals such as lithium, cobalt, and nickel; In the midstream, the high-end manufacturing sector has formed a new industrial chain centered on power batteries, motors, electronic control systems, smart chips, and sensors, characterized by high value-added and technology-intensive industries; In the downstream, the service ecosystem has spawned new business models such as charging infrastructure construction and operation, battery recycling and reuse, and

smart mobility, creating a large number of green job opportunities and further enhancing the green economic system.

Therefore, the new energy vehicle industry can form moderate industrial agglomeration, which can directly and significantly promote green economic efficiency and indirectly enhance green economic efficiency through green technological innovation. The agglomeration of EVs has a positive spatial spillover effect on green economic efficiency, which is conducive to the coordinated development of various regions.

3.3 Promoting Circular Economy and Efficient Resource Utilization

EVs are vital for advancing the circular economy. Critical minerals such as lithium, cobalt, and nickel can be recovered from used batteries and reintroduced into production, thereby reducing the need for new mining [10]. In addition, the EV industry enables second-life use of retired batteries, which further contributes to a true circular economy. Under typical conditions, traction batteries in new energy vehicles last about eight years; once capacity falls below 80% of the initial level, they no longer meet vehicle requirements and must be replaced. Since 2018, China's new energy vehicle batteries have gradually entered the retirement phase, and by 2025, the number of retired batteries is estimated to exceed 1.3 million tons [11]. Instead of immediate disposal, these batteries—especially $LiFePO_4$ (LFP) types—can be repurposed for stationary energy storage or restructured for use in low-speed EVs and energy storage stations, thereby fully leveraging their residual value [12]. A study in Batteries (2024) indicates that with proper balancing systems, second-life LFP batteries maintain stable capacity and low resistance, making them well-suited for extended use in stationary applications. When such cascading utilization is no longer feasible, the batteries can still be recycled to extract precious metals, such as lithium, cobalt, and nickel, thus realizing closed-loop resource utilization, reducing reliance on primary mineral extraction, and mitigating environmental pollution. By integrating recycling, reuse, and sustainable manufacturing, the EV sector fosters a closed-loop system that not only minimizes environmental impact but also supports long-term resource security.

3.4 Promoting Technological Innovation and Industrial Upgrading

EVs are at the forefront of technological innovation, integrating cutting-edge technologies such as new materials, artificial intelligence (AI), big data, cloud computing, the Internet of Things (IoT), and intelligent connected vehicle (ICV) technologies. For example, Intelligent connected vehicles are a key direction for the global automotive industry's transformation and upgrading. As a product of cross-industry integration among the automotive, telecommunications, and transportation sectors, intelligent connected vehicles have become a global hotspot for industrial innovation and a strategic high ground for future development. Industry data indicates that the scale of China's intelligent connected vehicle industry is projected to grow from 0.17 trillion yuan in 2019 to 1.3 trillion yuan by 2024, with an annual compound growth rate exceeding 50%, reflecting strong market confidence in the development of intelligent connected vehicles.

4 Conclusion

The development and adoption of EVs are crucial for driving the transition toward a green economy. As demonstrated, EVs contribute significantly to energy conservation, emission reduction, and environmental protection, especially when coupled with clean energy sources, thereby exhibiting strong zero-carbon potential. First, the EV industry enhances energy security and supports green energy development by replacing oil with renewable-based electricity and using V2G technology to stabilize the grid and integrate renewables. Second, the EV industry fosters a green supply chain from mining to services, driving industrial agglomeration, technological innovation, and spatial spillover effects that directly and indirectly enhance green economic efficiency. Third, the industry advances the circular economy by enabling second-life use and recycling of retired batteries, reducing reliance on primary mineral extraction, minimizing environmental impacts, and enhancing long-term resource security. Last, EVs drive technological innovation through integration with AI, IoT, and ICV technologies, positioning ICVs a strategic frontier of global automotive transformation.

According to the results, to further enhance the positive impacts of EVs on green economic growth, several recommendations can be made. Firstly, governments should continue to strengthen policy support, including targeted subsidies, incentives for renewable energy integration, and long-term regulatory frameworks that ensure stability for investors and manufacturers. Secondly, the circular economy model should be expanded by promoting large-scale battery recycling and standardized second-life applications to maximize resource efficiency. Thirdly, fostering technological innovation through research and development funding, international collaboration, and industry-university partnerships can accelerate breakthroughs in core EV technologies and related green industrial chains. Collectively, these measures will enable the EV industry to serve not only as a transportation solution but also as a central driver of sustainable economic transformation.

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