Proceedings of CONF-FMCE 2025 Symposium: Semantic Communication for Media Compression and Transmission
DOI: 10.54254/2755-2721/2025.GL28681

Feasibility Analysis and Path Exploration of Market-oriented Application of Pure Clean Energy Power Generation Vehicles

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Abstract. As global awareness of environmental issues grows, reducing vehicle exhaust emissions has become increasingly important. Pure clean energy-powered vehicles, which use renewable energy such as solar, wind, and hydroelectric power for charging or direct power supply, can achieve zero carbon emissions throughout the life cycle. This positions them as a key direction of the automotive industry's green transformation. Additionally, these vehicles leverage inexpensive energy sources that are readily available, further driving down the cost of operation. However, the market adoption of these vehicles remains in its early stages, hindered by challenges such as high manufacturing costs, immature energy storage technologies, and insufficient supporting infrastructure. This paper explores the feasibility of market-oriented application of pure clean energy-powered vehicles, analyzing the key factors influencing their promotion, including technology, economic considerations, and policy frameworks. By examining the various benefits of pure clean energy vehicles, this article concludes that significant obstacles still exist in achieving mass production and widespread adoption. It proposes actionable pathways to address these challenges and enhance the viability of clean energy vehicles in the market.

Keywords: Renewable energy, electric market, pure clean energy, vehicles

1. Introduction

With the advancement of technology, the improvement of vehicle manufacturing technology has directly accelerated the popularization of cars. Every moment, billions of various types of cars are driving on the roads. With the continuous increase in population, people's demand for cars and the energy used to power them is also growing larger and larger. This inevitably leads to more exhaust emissions. Excessive greenhouse gases remaining in the atmosphere cause the climate to become increasingly extreme, and severe weather phenomena occur frequently. Studies show that due to global warming, the melting of glaciers has caused the sea level to rise by 10-20 cm compared to 100 years ago, which will have a great impact on marine ecology and make coastal areas more vulnerable to floods and extreme storms [1]. Moreover, rising temperatures can enhance mosquito activity, expand the range of infectious diseases, and elevate health risks for populations. Addressing these threats is critical, as carbon dioxide emissions from vehicle engines are a primary contributor to greenhouse gases, highlighting the urgent need for pure clean energy vehicles.

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Current geopolitical tensions—such as the Israel-Hamas conflict and the Russia-Ukraine war, both involving major oil-exporting nations—have further inflated oil prices, making them increasingly unaffordable. In contrast, clean energy sources, which are cheaper and accessible through various means, present an emerging and ideal alternative, although their feasibility for large-scale application remains in question. Existing studies on new energy vehicles mainly focus on battery electric vehicles (BEVs). In contrast, research on pure clean energy-powered vehicles is relatively scarce, with Zhang exploring the technical feasibility of solar-powered vehicles but failing to involve market-oriented analysis [2].

This paper adopts a literature review method to analyze the feasibility of pure clean energy-powered vehicle marketization from the perspectives of technology, economy, and policy, while also exploring potential paths for promotion. It is expected to supplement the research gap in this field and provide practical references for policy formulation and enterprise decision-making.

2. Technology

The first topic of discussion is whether the current science and technology can ensure the safety of vehicles and enable mass production. Undeniably, new battery technologies offer hope for improving the range of pure electric vehicles [3]. Solid-state batteries, with their high energy density, can guarantee vehicle range and may help pure electric vehicles easily exceed 1,000 kilometers in the future, greatly alleviating people's anxiety about insufficient range [4]. The efficiency of charging with clean energy is also not low. For instance, in solar vehicles, the photoelectric conversion efficiency of solar panels is continually improving. The new photovoltaic coating developed by Mercedes-Benz is only 5 microns thick and weighs 50 grams per square meter, but its photoelectric conversion efficiency exceeds 20%, and it can cover the entire vehicle, greatly increasing the area and amount of solar energy collected [5].

However, pure clean energy vehicles still have a series of limitations at present. The most significant challenge is their susceptibility to environmental conditions, making widespread promotion difficult in all regions. Solar vehicles, for example, rely heavily on sunlight; during rainy or cloudy days, at night, or in areas with insufficient sunlight, their range can drop dramatically [6]. Even in areas with abundant sunlight, due to the low conversion efficiency of solar panels, the improvement in range is rather limited. For instance, the world's first mass-produced solar car, "Lightyear 0", can only provide a range of 70 kilometers per day under ideal conditions with its solar panels. In bad weather, the range is even harder to guarantee.

Moreover, solar panels age and deteriorate over time, and those installed on the roof are vulnerable to external damage. In regions with frequent rain, their practicality is greatly reduced, further increasing the cost and inconvenience of use. Not only is range a major issue, but the price of the vehicle itself also deters most buyers. Due to the need for a large amount of high-tech materials and complex technologies, and the low conversion rate of solar panels, more panels need to be installed to ensure power, resulting in a significant increase in manufacturing costs [7]. For example, the world's first mass-produced solar car, "Lightyear 0", equipped with 5 square meters of solar panels and a power generation capacity of only 1.05kW, has a price tag of 250,000 euros (approximately 1.76 million yuan), which makes it unaffordable for ordinary consumers. The high cost is contrary to the purpose of developing such vehicles.

Despite the limitations of solar vehicles, ongoing technological advancements may pave the way for overcoming these technical bottlenecks. If issues related to cost, range, and charging infrastructure can be addressed, pure clean energy vehicles still hold considerable promise for short-distance travel and specific scenarios, such as shuttle buses in scenic areas and public transportation.

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This could contribute uniquely to the sustainable and harmonious development of humans and nature.

3. Economy

Another factor is the economic one. The economic development level of a country or region will directly affect the attitude of the country and government towards protecting the environment and investing in the high-cost research and development of pure clean energy vehicles. In the current context of global energy structure transformation and the rising awareness of environmental protection, clean energy vehicles have become an important direction for the development of the automotive industry. However, many countries face severe economic constraints in the process of exploring clean energy vehicles, which seriously hinder technological breakthroughs and the large-scale development of the industry.

Research and development investment is the primary economic constraint. Take electric vehicles as an example. The core technologies such as power batteries and motor control systems are difficult to develop and have long research and development cycles, requiring continuous investment of a large amount of funds. According to the report, it takes an average of 5 to 8 years for a mature electric vehicle model to go from research and development to market launch, with research and development costs exceeding 1 billion US dollars [8]. For countries with limited economic strength, such high research and development costs are difficult to bear, let alone promoting them at low prices to the general public. For instance, a Southeast Asian country attempted to independently research and develop advanced power battery technology a few years ago, but due to a shortage of funds, it was difficult to attract top scientific research talents, and the experimental equipment was outdated and backward. Eventually, it had to give up the independent research and development of some key technologies and rely on imported technologies. This not only increased the cost of technology use but also made the country dependent on others in terms of technology.

Once research and development are completed, manufacturing presents another challenge. Even if a vehicle is successfully developed, the high manufacturing cost greatly limits its market competitiveness. The production of clean energy vehicles involves many advanced materials and precision components. Take the lithium-ion battery of an electric vehicle as an example. The prices of raw materials such as cobalt and nickel fluctuate frequently and the supply is unstable. According to a report by the International Energy Agency (IEA), the cost of batteries accounts for 30% to 40% of the total cost of an electric vehicle. Some countries, due to a lack of relevant raw material resources, are highly dependent on imports, making manufacturing costs highly susceptible to fluctuations in the international market [9]. For example, in a certain Eastern European country, the cost of assembling an electric vehicle is about 30% higher than that of importing a traditional fuel vehicle. The high manufacturing cost makes the final selling price beyond the affordability of consumers, resulting in extremely poor market sales.

If some countries that cannot support continuous research and development still blindly import from foreign countries in the name of environmental protection, the high prices will eventually deter both customers and related research and development enterprises, leading to severe losses for the country. Some countries have set high tariffs and other trade barriers to protect their domestic automotive industries. For instance, a certain South American country imposes a tariff of up to 50% on imported electric vehicles, which significantly increases the price of imported clean energy vehicles. This not only hinders the entry of advanced technology products into the domestic market but also makes it difficult for domestic enterprises to improve their technological level and industrial competitiveness through learning and reference.

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In conclusion, economic factors severely restrict the development of clean energy vehicles in some countries from multiple dimensions such as research and development, manufacturing, infrastructure construction, market demand, and international trade. To break through this predicament, it is necessary for the government, enterprises, and society to work together, formulate reasonable policies, innovate business models, and increase investment to gradually solve the economic constraints and promote the healthy and sustainable development of the clean energy vehicle industry.

4. Policy

The last influencing factor to consider is policy. Throughout the process, energy continuously powers the car. The large fan will occupy a lot of space, highlighting the parking problem. At the same time, due to its large footprint, a country's attitude towards the research and development of clean energy vehicles will also be indirectly reflected in the formulation of policies, and the responsible research and development enterprises will be forced to accept the policies. For example, if a country attaches great importance to the research and development of solar-powered vehicles and intends to regard them as the ideal vehicles of the future, then the country will try its best to fund and encourage enterprises to conduct research and development under the premise of not violating the current social order. For instance, the research and development of solar-powered vehicles requires a large amount of investment in multiple key aspects such as improving the efficiency of solar panels, innovating energy storage technology, and optimizing the overall design of the vehicle. To focus on research without distractions, the government must do its best to maximize the funding for enterprises. If a country's government can set up special funds or encourage enterprises to increase research and development investment through tax incentives, it will strongly promote breakthroughs in solar-powered vehicle technology. Take a developed country as an example: the government provides up to 50% of the funding for solar-powered vehicle research projects, attracting many enterprises and research institutions to participate, significantly accelerating the development speed of new and efficient solar panels. Conversely, if the policy lacks financial support, enterprises will be unable to maintain long-term and high-cost research and development due to financial pressure, and technological progress will be severely hindered.

At the same time, infrastructure construction policies have a profound impact on the research and development of solar-powered vehicles. The construction of infrastructure such as charging stations and swap stations directly relates to the convenience of using clean energy vehicles. If the policy strongly supports infrastructure construction, such as the planning for the construction of charging facilities for new energy vehicles, and can create conditions for the popularization of solar-powered vehicles, enterprises will be more confident in increasing research and development efforts and developing models that are more compatible with the infrastructure [9]. On the contrary, if infrastructure construction is lagging behind, even if enterprises develop advanced solar-powered vehicles, they will be unable to promote them due to inconvenient use, and the research results will not be transformed into actual benefits, dampening the enthusiasm of enterprises for research and development.

Finally, an often-overlooked issue is that pure clean energy vehicles generally require considerable space, which may not comply with existing vehicle space regulations. For example, if there is a car driven by wind energy in the future, it must install a large fan on the roof to facilitate use in the existing parking area, but it will not be sufficient. Then new policies must be implemented to actively solve the problem. Otherwise, if buyers find that parking has become a problem, they

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will probably not buy solar-powered vehicles, which will greatly hinder the promotion of clean energy vehicles.

In conclusion, the development of solar-powered vehicles in a certain country is constrained and promoted by various factors related to public policies. The government needs to comprehensively consider these factors and formulate reasonable and comprehensive public policies to create a favorable environment for the development of solar-powered vehicles, promote the healthy development of the industry, and contribute to achieving the sustainable development goals in the transportation sector.

5. Conclusion

In conclusion, pure clean energy vehicles, due to their advantages such as zero carbon emissions throughout the entire life cycle and low energy costs, have become the ultimate direction for addressing global climate issues and energy crises, and promoting the green transformation of the automotive industry. The paper systematically analyzed the feasibility of its market application and the core constraints from the technical, economic, and policy perspectives: At the technical level, although there are breakthroughs such as solid-state batteries and efficient photovoltaic coatings, the problems of strong environmental dependence and high manufacturing costs are prominent; at the economic level, it is restricted by factors such as large R&D investment, fluctuations in raw material prices, and trade barriers; at the policy level, the funds support, infrastructure planning, and space adaptation policies play a key role in promoting or restricting the development of the industry, and it is proposed that multiple parties need to collaborate to solve the difficulties.

However, the paper has obvious limitations. First, there is insufficient factual data, and specific quantitative data on the promotion rate of pure clean energy vehicles in different countries and the implementation effect of policies are missing in key argumentation links, which weakens the comprehensiveness and support of the analysis. Second, the authenticity is difficult to determine. Some cited content does not clearly indicate the authoritative source and detailed background, such as some national research cases and literature viewpoints that lack reliable channels for verification, which cannot ensure the authenticity of the information and, to some extent, affects the credibility of the research conclusion and also indicates the improvement direction that additional empirical data and verification of information authenticity need to be supplemented for subsequent related research.

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