Analysis of CCER Policy Application in the New Energy Vehicle Industry

Meixi Liang

School of Economics & Management, Beijing Forestry University, Beijing, China

Liang220401911@bjfu.edu.cn

Abstract. As China's economy is booming, the issue of carbon emissions is becoming increasingly prominent. In terms of policy, China has established a domestic CCER mechanism to improve the carbon trading market, and the future development of CCER policy has received much attention, but there are still deficiencies in synergistic development with specific industrial sectors. This paper explains the CCER restart process based on the progressive policy model, through the analysis of energy type suitability, the future development path of new energy vehicles, and the existing CCER methodology, combined with the example of the development of new energy vehicle industry in Guiyang City, Guizhou Province, effectively demonstrates the suitability of new energy automobile industry and renewable energy CCER projects, and explores the combination of the two. It also explores the path of "light storage, charging and discharging", and then puts forward the following suggestions for CCER policy development: improve the policy content and strengthen the policy synergy.

Keywords: CCER policy, new energy vehicles, CCER renewable energy type projects.

1. Introduction

With the rapid development of industrialization and urbanization, human activities have led to the emission of large quantities of carbon dioxide and other greenhouse gases into the atmosphere, and the increase in greenhouse gases has triggered global climate change and numerous environmental problems, with carbon emissions undoubtedly being one of the major issues facing the world. China, as a responsible developing country, practices the concept of the community of human destiny and has committed to the world to achieve carbon peaking by 2030 and carbon neutrality by 2060. Reducing the proportion of coal consumption is a necessary way to achieve "carbon peak and carbon neutrality" [1]. Currently, China's carbon market is dominated by carbon quotas and state-certified voluntary emission reductions (CCERs), and the CCER trading scheme is an important complementary mechanism to the carbon market [2, 3]. In terms of carbon emission reduction, China vigorously promotes the development of new energy vehicles with remarkable results, and by 2022, China's new energy vehicle production and sales volume will remain the world's first for eight consecutive years [4]. With the continuous improvement of China's energy development and utilization technology and the increase in the ownership of new energy vehicles, the development and application of carbon assets in the use phase of new energy vehicles have been initially explored [5]. At present, the signal of CCER policy restart is becoming clear, based on the environmental protection and sustainability of new energy, this paper tries to explain the suitability of renewable energy projects and the new energy automobile industry in CCER from the perspective of policy, feasible paths and example analysis, and explores the future development path of CCER policy.

2. Analysis of CCER and New Energy Vehicle Industry Policy Perspective

2.1. Analysis of CCER Core Concepts

CCER is the abbreviation of China Certificated Emission Reduction, which refers to the quantitative verification of projects in China that contribute to reducing greenhouse gas emissions from renewable energy projects, forestry carbon sinks, methane utilization projects, etc. [6]. The certified emission reductions (CCERs) can be used for trading in the local carbon market or the

national carbon market. In addition, CCERs are an asset that can be used for compliance by emission-control enterprises other than quotas in the carbon market, and they are a kind of carbon offset credits, that are used to offset China's greenhouse gas emissions. In essence, it is a carbon offsetting mechanism, whereby emission-control enterprises purchase certified emission reductions (CERs) that can be used to offset their carbon emissions from enterprises that have implemented "carbon offsetting" activities [6]. High-emission enterprises can purchase allowances from other compliant enterprises or partially offset with purchased/self-developed CCER projects if their initial free allowances are insufficient, to offset their actual carbon emissions in the end. CCERs have nothing to do with the carbon quotas of the emission control enterprises but mainly come from projects that can generate emission reductions, such as wind power, photovoltaic, forestry carbon sinks, and so on.

2.2. Analysis of the CCER Policy Restart Process Based on Progressive Policy Modelling

Although the CCER policy was pressed the pause button in 2017, the information related to the policy remained active afterward. One year after the suspension, the national voluntary emission reduction trading registration system resumed operation, and the CCER transaction filing application did not affect the participation of CCERs that had already been filed in the transaction, only the incremental project filing application had been stagnant. This side shows that the CCER policy has vitality, the subsequent incremental project filing will have reopened the possibility, but the specific time can not be predicted. 2021, the Ministry of Ecology and Environment issued a notice to clarify the specific requirements for the clearing of the payment: first, the offset ratio of no more than 5% of the carbon emission allowances should be cleared; second, it shall not be from the emission reduction projects included in the management of quotas in the national carbon market [7]. Recalling the issue of project irregularities mentioned in the 2017 moratorium announcement, the clarification of the carbon allowance offset ratio is an initial response to this issue, reflecting the official body's continued attention to the CCER policy. In addition, in 2020 China has proposed carbon peak and carbon neutral "3060" targets. As the world's top carbon emitter, China's carbon dioxide emissions increased by 750 million tonnes in 2019, reaching a total of 11.5 billion tonnes, accounting for about 32% of total global carbon emissions. The severe environmental pollution situation and resource constraints constrain the sustainable development of the economy, and China is facing great pressure to reduce emissions under the constraints of the "double carbon" target [8]. According to the above realistic background, the relevant departments through the provisions of the CCER policy in the carbon offset quota, to a certain extent, to promote the improvement of the policy, is undoubtedly an effective step towards the "dual-carbon" target.

From the policy signal point of view, 2023 is undoubtedly the CCER policy restart to the climax of the historic period. 2023 February, the Ministry of Ecology and Environment to deal with climate change division director of the speech disclosed that it is necessary to build a unified and standardized carbon emissions statistics accounting system, as soon as possible to start the national greenhouse gas voluntary emission reduction market, and steadily promote the construction of market infrastructure. The Ministry of Ecology and Environment, as the "Commanding General" of CCER's overall policy, undoubtedly enhanced the credibility and influence of the speech and also constructed the corresponding macro background conditions for the relaunch of CCER. Subsequently, the launching ceremony of the "National Green Exchange" for the whole world was completed, and the development of the national unified CCER registration and trading system has been completed, which is waiting for the acceptance of the competent authorities. As the first report on CCER development progress in 2023, this is also regarded as a key signal for the re-launch of CCERs. One month later, the Ministry of Ecology and Environment issued relevant documents clarifying the areas of methodology solicitation, compilation principles, compilation contents, etc., and provided methodology compilation outlines, project case compilation outlines, and methodology application forms, which are used to standardize and help each unit to better compile the methodology. The CCER development process is divided into the project assessment phase, the filing phase, the trading phase, and the cancellation phase. In the project evaluation stage, the specific tasks are to select the

corresponding methodology according to the project type and to prepare the project design documents according to the requirements of the methodology. It is easy to see that the methodology plays an important role in the initial evaluation stage of CCER projects, and only by choosing the methodology that is suitable for the development project can the project design document be written and then enter the subsequent review. Up to the CCER primary market before the interruption, the competent department has published 12 batches of methodologies for the record list, a total of 200 methodologies, of which only 27 belong to the domestic newly developed, and the rest belong to the CDM methodology directly transformed from [9]. It can be seen that the methodologies do have problems such as insufficient innovation and insufficient variety. The action of the Ministry of Ecology and Environment to openly solicit methodologies from society is a manifestation of actively improving the existing policies after realizing the existing problems. The regulatory entity of the CCER mechanism is a national government agency, and its future restart depends on the confidence of the public regulator in its standardization [10]. Thus, the signal of CCER restart is becoming more and more obvious, and in the face of this policy restart, the relevant project areas should do a good job in the direction of positioning, and seize the first opportunity to achieve high-quality development.

2.3. Current Status of Policies on the Development of the New Energy Vehicle Industry

The Ministry of Ecology and Environment (MOE) previously released an annual report announcing the national environmental management of mobile sources in 2022. The annual report shows that mobile source pollution has become an important source of air pollution in China's large and medium-sized cities, and the urgency of strengthening the management of mobile source pollution is becoming more and more prominent. In 2022, the total emissions of four pollutants from motor vehicles (including cars, low-speed vehicles, motorbikes, trailers tractors, etc.) across the country were 14.662 million tonnes [7]. Among them, carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM) emissions were 7.430 million tonnes, 1.912 million tonnes, 5.267 million tonnes, and 53,000 tonnes, respectively, with automobile emissions accounting for more than 90% of CO, HC, NOx, and PM emissions [7]. Among them, NOx emissions from diesel vehicles exceed 80% of total vehicle emissions and PM exceeds 90%; CO and HC emissions from petrol vehicles exceed 80% of total vehicle emissions [7]. It can be seen through the pollutant emissions from motor vehicles that automobiles are the main contributor to total pollutant emissions, with petrol vehicle pollutant emissions accounting for the majority of total vehicle emissions, which has a significant impact on air quality, and mobile source pollution management in the petrol vehicle sector is imminent. In addition, among the nine priorities put forward by the Central Economic Work Conference in 2023, the "in-depth promotion of the construction of ecological civilization and green and low-carbon development" is listed. Low carbon is undoubtedly a key task for the country and all the people of China at present and for a long period in the future, and the control of carbon emissions in China's transport sector is becoming more and more urgent. Recently, China's State Council issued a document to extend and optimize the vehicle purchase tax exemption policy for new energy vehicles by extending the tax exemption period and setting the exemption limit. And China's State Council in the release of the new energy automobile industry development plan pointed out that to vigorously advocate the development of China's new energy automobile industry [7]. According to the Chinese government website, statistics show that China's new energy vehicle sales of 6,887,000 units in 2022, the market share increased to 25.6%, higher than the previous year's 12.1 percentage points, the global sales accounted for more than 60% [5]. Among them, 5.365 million pure electric vehicles were sold, up 81.6% year-on-year; 1.518 million plug-in hybrid vehicles were sold, up 1.5 times year-on-year [5]. Based on the objective needs of mobile source pollution control problems in the field of gasoline vehicles, the strong support of government policies, and the gradual maturity of new energy vehicle technology, the new energy vehicle industry, which has both ecological and economic benefits, has a broad development prospect in the future.

Based on China's future low-carbon goals, as well as the government's positive policy orientation towards both, CCER policy and the new energy vehicle industry have the same development goals,

and have the possibility of working hand in hand to realize the ecological value, the following is a detailed description of the suitability of renewable energy CCER projects and new energy vehicle industry.

3. Analysis of the Suitability of New Energy Vehicle Industry and Renewable Energy Type Ccer Projects

3.1. Overlapping Nature

New energy and renewable energy have different meanings and should not be confused. The main features of new energy are renewability, low carbon emission, high technological content of development and utilization, decentralization, long-term, cleanliness, and sustainability. At present, in international practice, new energy includes small hydropower, solar energy, wind energy, modern biomass energy, geothermal energy, ocean energy, hydrogen energy, fuel cells, large and medium-sized hydropower, and nuclear energy are regarded as conventional energy. The main characteristics of renewable energy are renewability, decentralization, environmental protection, diversity, geography, and long-term, etc., mainly including wind, solar, hydro, biomass, geothermal energy, ocean energy, and other non-fossil energy. It is not difficult to see that, although the two are independent of each other's concepts, in the characteristics of the similarity in the concept of specificity referred to in the scope of energy there is a more obvious overlap, such as solar energy, hydroelectric energy, biomass energy, which belongs to both renewable energy, but also belongs to the new energy, and these have a dual nature of energy is expected to be the link between the two types of energy applications of the key.

3.2. Feasibility of "Optical Storage, Charging and Discharging" Path of Development

Focusing on the field of new energy vehicles, although new energy vehicles are on the rise in terms of ownership, the current layout of charging facilities has become an important constraint on the development of the industry. "Difficulty in charging has become a major obstacle to the purchase of new energy vehicles. Many industry insiders believe that "optical storage charging and discharging" is an important development direction of the energy industry, and cracking the bottleneck of new energy vehicle industry development is of great significance. Optical storage charging and discharging refers to the use of photovoltaic power generation, and then the use of energy storage equipment to effectively store and use the power, in a small cycle to achieve the effective use of electricity [11]. Photovoltaic energy as energy from the sun is a renewable energy source, in addition, photovoltaic energy can use the sun's energy to generate electricity or other forms of energy conversion and does not produce carbon dioxide and other greenhouse gas emissions, but also a new source of energy to meet the aforementioned "energy with a dual nature". In the report released by the European Union, it is pointed out that IT technology and policy to promote the integration of all-electric vehicles into one energy storage system can enhance the resilience of the power grid, expanding the space for new energy consumption [11]. And China Energy Bureau recently released data showing that as of the end of June this year, the total installed capacity of renewable energy power generation exceeded 1.3 billion kilowatts, reaching 1.322 billion kilowatts, an increase of 18.2% year-on-year, accounting for about 48.8% of China's total installed capacity. Among them, solar power installed capacity is the largest, reaching 471 million kilowatts. In the development of renewable energy in full swing, solar photovoltaic power generation has become the "main force", and gradually released a huge development potential. Relevant experts pointed out that the future of the photovoltaic industry is to better integrate into the new energy power system, to further reduce costs, promote low-cost transformation, and crack the energy transition "impossible triangle" [11]. Coupled with China's photovoltaic industry has been in a leading position in the world, so from the direction of renewable energy technology development, the photovoltaic power plant construction

direction of the implementation of the action is indeed the development of the electric vehicles industry feasible ideas.

Returning to the CCER project itself, after the suspension of new project applications in 2017, the existing CCER market stock is insufficient, and there is a large demand gap, after its restart will be widely incorporated into new projects to achieve a balance between supply and demand, which can provide a broad market for new energy automobile industry to join. From the perspective of the types of CCER projects that have been validated, renewable energy accounts for 71% of the existing 2800 projects, which is the main supply of CCERs [12]. Numerous project cases can provide reference experience for the combination of the new energy vehicle industry and future CCER. Secondly, from the CCER development process mentioned before, if enterprises want to develop in the CCER policy track in the long run, choosing the matching methodology, preparing qualified project design documents, and successfully passing the project audit in the first stage are the primary conditions. Among the methodologies that have been filed so far, those related to carbon emission reduction accounting for new energy vehicles include CMS-048-V01, CMS-053-V01, and CMS-098-V01. These methodologies lay the theoretical foundation for the combination of CCER and new energy vehicles. Among them, the CMS-098-V01 methodology, i.e., Greenhouse Gas Emission Reduction Methodology for Electric Vehicle Charging Stations and Charging Piles, applies to projects that operate through electric vehicles instead of traditional energy vehicles and charge at charging stations and charging piles [13]. With the aforementioned new energy vehicle industry in the future, the "optical storage charging and discharging" road direction is compatible. If the new energy vehicle industry participates in CCER projects from the path of "optical storage, charging and discharging" in the future, the methodology can be improved based on the original, and the design cost can be reduced to a certain extent, which further proves that the new energy vehicle industry is expected to be combined with CCER.

3.3. Feasibility Analysis of New Energy Vehicle Development Practice

The previous section explained the feasibility of combining new energy vehicles and CCERs from the perspective of "optical storage, charging and discharging", and the following is a feasibility analysis of Guiyang City as an example of the current development practice of new energy vehicles in the Chinese region. In 2023, the Guiyang municipal government announced a catalog of new energy vehicle models exempted from vehicle purchase tax (the sixty-ninth batch), listing 398 types of pure electric vehicles, plug-in hybrid vehicles, and fuel cell vehicles that are eligible for exemption from the vehicle purchase tax, which to a certain extent stimulates the local people's willingness to buy new energy vehicles, and at the same time demonstrates the positive attitude of the Guiyang municipal government to accelerate the development of the new energy vehicle industry. automobile industry construction with a positive attitude [14]. It is noteworthy that, in response to Guiyang City's "One Circle, Two Fields, and Three Changes Construction", the "Guiyang City New Energy Vehicle Intelligent Charging Pile Project and Low Carbon Park Demonstration Project of Bokai Pharmaceutical Logistics Park" was formally launched in Bokai Pharmaceutical Logistics Park, Guizhou, in December 2023 [15]. In December 2023, the "Guiyang New Energy Vehicle Smart Charging Pile Project and Demonstration Project of Low Carbon Park in Bokai Medicine Logistics Park" was officially launched in Guizhou Bokai Medicine Logistics Park. The project intends to use the roofs of the factory buildings and the surface car parks in the park to build rooftop distributed photovoltaic (PV) power stations and smart charging stations. In the project, the rooftop distributed PV power station will be operated in the mode of "self-generation and self-consumption, with surplus power going online", and with the gradual increase of electric cars in the park in the future, the charging network will be a large number of electric cars in the park and the gradient utilization of the batteries, which will be linked into a huge mobile energy storage network, and will be able to store the photovoltaic power during the time of great power generation and the grid's low price in the low valley. Period for storage, in the grid peak high price period, and then the car and the battery surplus of cheap electricity or green power reverse discharge supply park use, or even the formation of a

virtual power plant delivery to the grid, in the park to reduce the cost of energy use at the same time, the electric car owners can also earn the middle price difference, not only to achieve the charging of high-efficiency and ecological and environmental protection objectives, but also to increase the economic benefits, and reverse promote the project and the new energy automobile industry's further development [15]. development [15]. At the same time, the construction and use of photovoltaic charging facilities in the project emphasize the storage of photovoltaic power, which is consistent with the "optical energy charging and discharging" path analyzed in the previous section and is in line with CCER's existing methodology for the construction of charging stations. It has also been shown that when individuals have more infrastructure in a city, they are more likely to purchase cars that use renewable energy [16]. This further confirms the feasibility of combining the two.

4. Suggestions for the Future Development of CCER Policy

4.1. Improvement of Policy Content

The improvement of policy content mainly includes the improvement of methodology and carbon quota content. The improvement of methodology is reflected in the promotion of feasible technologies such as "optical storage, charging and discharging", the collection of data and statistics based on relevant examples, and the improvement of the relevant calculation models in a large number of practical tests, to improve the efficiency and accuracy of the accounting of carbon emissions. Among the CCER methodologies that have been filed so far, CMS-098-V01 is the main methodology related to the promotion of the practice of optical storage, charging, and discharging. It belongs to the fuel substitution methodology and includes two parts in the baseline calculation, namely, project emissions and baseline emissions. The project emissions are obtained by multiplying the carbon emission factor of the electricity consumed by the project vehicle and the charging volume of the project vehicle, taking into account the average losses in the transmission and distribution of electricity technology [4]. In the "optical storage charging and discharging" path, the enterprise belongs to the use of renewable energy to generate electricity, so the carbon emission factor of the electricity consumed by the vehicle is zero, and the average loss of the transmission and distribution of electricity technology is also multiplied to zero. Thus, in this particular case, attention needs to be paid to the issue of the amount of losses generated during the actual use of photovoltaic charging piles. Therefore, in the subsequent improvement of the methodological model, the generality and specificity of the project should be fully considered, the purpose of emission reduction should be taken into account, and new technologies such as big data, cloud computing, Internet of Things, block chain, artificial intelligence, remote sensing satellites and other new technologies should be combined to further improve the means of emission reduction accounting and monitoring, to enhance the reliability of the values of the accounting parameters, and to strengthen the precision and quality of the emission reduction accounting data, and to enhance the accuracy and quality of the data used in calculating the amount of electricity stored in the photovoltaic charging pile and the rate of electricity loss during the charging process. and the accuracy of the power loss rate in the charging process, which can further determine whether the loss value can be specified in the form of a constant amount [9]. In addition, from the perspective of photovoltaic power generation, the indirect economic leakage triggered by changing product prices in the supply and demand market should also be considered, i.e., a large number of photovoltaic power generation projects will reduce the demand for coal, thus lowering the price of coal resources, which may lead to an increase in the generation of power from other coal-fired power plants, and thus offset to some extent the ecological benefits originally provided by CCER [17]. Therefore, to avoid such a situation, the Chinese government can constrain the carbon quota according to the carbon emission intensity of enterprises, and use the green financial industry chain and other carbon market-supporting facilities, to reduce the risk of carbon leakage between different industries through the internal and external linkage of the market.

4.2. Strengthening Policy Synergy

To combine the development of new energy vehicles with the development of the carbon emissions trading market, CCER is the policy party that provides the new energy vehicle industry with the prerequisites to enter China's carbon emission reduction trading market, and it should pay attention to the potential development advantages of the new energy vehicle industry under the overall national policy, give positive policy guidance signals through policy synergy, and contribute to the win-win situation of the two fields to carry out the goal of sustainable development. The relevant person in charge of Guiyang City's smart charging pile construction project pointed out that excess electricity from PV power generation and charging piles can be supplied to the park for use when the grid peaks at high prices [15]. Although the CCER mechanism is not introduced here, the developer of this PV power plant has the conditions to become a CCER participant. The developer can either use the results of the PV power generation to offset part of the carbon allowances in the carbon trading market or act as a seller by converting the excess electricity into CCERs itself and selling them to other high-emission enterprises in the park. This not only gives the developer more economic benefits and strengthens the links between the companies within the park, but also helps to achieve the goals of full utilization of resources, environmental protection, and sustainability. The country can build a cooperation mechanism at multiple levels, including the government and new energy vehicle enterprises, to strengthen communication and collaboration between all parties, so that the CCER policy and the new energy vehicle policy can be developed in synergy, and jointly promote the healthy development of the new energy vehicle industry and the carbon emission rights trading market.

5. Conclusion

In summary, with the continuous progress of technology and the continuous support of policies, the combination of the new energy automobile industry and the carbon emission rights trading market will have a broad development prospect. On the one hand, the large-scale promotion and application of new energy vehicles will effectively reduce carbon emissions and help achieve the goal of carbon neutrality; on the other hand, the trading of CCERs will provide more funds and support for the new energy vehicle industry and promote its rapid development. Therefore, the combination of the new energy automobile industry and the carbon emission rights trading market will lead to sustainable economic development while achieving environmental protection goals. To achieve this goal, the relevant departments need to continue to increase technical research and development and policy support, strengthen the publicity and promotion of new energy vehicles and carbon emissions trading, enhance public awareness and acceptance of environmental protection and new energy vehicles, and promote the large-scale application of new energy vehicles and the rapid development of the carbon emissions trading market. At the same time, international cooperation and exchanges should be strengthened to jointly promote the synergistic development of new energy vehicles and carbon emission rights for win-win cooperation.

References

[1] Geng L, Hu J, Shen W. The impact of carbon finance on energy consumption structure: Evidence from China. Environmental Science and Pollution Research, 2023, 30 (11): 30107-30121.

[2] Park C Y, Meng T, Zheng W Y, et al. A study on the valuation of corporate carbon assets under the perspective of carbon trading. Price Theory and Practice, 2023, 8: 81-86.

[3] Zhang Y J, Liu J Y, Woodward R T. Has Chinese Certified Emission Reduction Trading reduced rural poverty in China? Australian Journal of Agricultural and Resource Economics, 2023.

[4] People's Daily. China's new energy vehicle production and sales for 8 consecutive years is the world's first, 2023. Retrieved from https://www.gov.cn/xinwen/2023-01/24/content_5738622.htm.

[5] Ren H H, Li B Y, Xia L N, et al. Current status and application outlook of carbon asset development for new energy vehicle traveling in China. Petroleum and Petrochemical Green Low Carbon, 2022, 7 (06), 1-6.

[6] Fang K, Mao M Y, Liu X, et al. The commonwealth effect of dual-carbon policy instruments--A study based on county data from China's certified voluntary emission reduction projects. Journal of Zhejiang University (Humanities and Social Sciences Edition), 2023, 53 (02): 101-115.

[7] Ministry of Ecology and Environment of the People's Republic of China. Ministry of Ecology and Environment Releases Annual Report on Environmental Management of Mobile Sources in China, 2023. Retrieved from https://www.mee.gov.cn/ywgz/dqhjbh/ydyhjgl/202312/t20231207_1058461.shtml.

[8] Liu Y X, Luo X, Zhang W R, et al. Study on the impact of carbon emission allowance allocation rules on coal power revenue. Progress in Climate Change Research, 2023, 19 (03): 334-346.

[9] Huang S J. Dilemmas and countermeasures of China's CCER restart under the carbon neutrality target. Southwest Finance, 2023, 10: 18-30.

[10] Chen L, Xie M. How do hard regimes absorb, overlap, and squeeze out soft regimes? Insights from global carbon markets. Global Public Policy and Governance, 2023: 1-26.

[11] International Energy Network. Photovoltaic global pattern accelerates reconstruction, the industry must continue to innovate to consolidate the leading position, 2023. Retrieved from https://www.jiemian.com/article/9801425.html.

[12] Zheng Y C, Xu Z R. Exploration of renewable energy CCER additionality under new market environment. China Power Enterprise Management, 2023, 22: 54-56.

[13] Anonymous. CM-098-V01 Greenhouse gas emission reduction methodology for electric vehicle charging stations and charging piles, 2022. Retrieved from http://cdm.ccchina.org.cn/archiver/cdmcn/UpFile/Files/Default/20150127153817016318.pdf.

[14] Guiyang Municipal People's Government. Announcement of the Ministry of Industry and Information Technology of the People's Republic of China No. 21 of 2023, 2023. Retrieved from https://www.guiyang.gov.cn/zwgk/zdlyxxgkx/gyfz/zbgygl_5740764/202309/t20230915_82415228.html.

[15] Guiyang Municipal People's Government. 50 charging stations to be built! Guiyang City New Energy Vehicle Intelligent Charging Pile Project and the Launch of Low Carbon Park Demonstration Project in Bokai Pharmaceutical Logistics Park, 2023. Retrieved from https://www.guiyang.gov.cn/zwgk/zwgkxwdt/zwgkxwdtbmdt/202312/t20231226_83398310.html.

[16] Almatar K M. Increasing electric vehicles infrastructure in urban areas for efficiently employing renewable energy. Environment, Development and Sustainability, 2023: 1-22.

[17] Ye H, Zhang Q, Pan X, et al. Market-induced carbon leakage in China’s certified emission reduction projects. Mitigation and adaptation strategies for gl obal change, 2020, 25 (6): 987-1012.