Balancing Acts: Evaluating the Impact and Alternatives of Carbon Taxes and Renewable Energy Subsidies on Climate Change

Lirong Yao

Beijing, China

yaolirong.lily@gmail.com

Keywords: Climate Change, Carbon Taxes, Renewable Energy Subsidies

Abstract: Climate change driven by greenhouse gas emissions is urgent for effective policy interventions to transition to a sustainable, low-carbon future. Carbon taxes and renewable energy subsidies are two prominent policy tools aimed at combating climate change. In this paper, we compare the effectiveness of carbon taxes and renewable energy subsidies in reducing emissions, noting that while carbon taxes provide a broad incentive across sectors, their impact depends on the tax rate and the availability of alternatives. Renewable energy subsidies, in contrast, directly promote clean energy but require robust grid infrastructure and storage technology to be fully effective. The essay concludes that neither policy is a panacea, and a combination of both, along with other mechanisms such as cap-and-trade systems, carbon dividends, and direct investment in green technologies, may be the most effective approach. Policymakers must carefully balance the strengths and weaknesses of each policy to ensure a fair and sustainable transition to a low-carbon future.

1. Introduction

Climate change is one of the most urgent global challenges, primarily brought about by increased emissions of greenhouse gases, particularly carbon dioxide (CO_2), from human activities related to the consumption of fossil fuel. As the negative effects of climate change escalate, governments worldwide have devised policy tools to reduce emissions in an effort to transition to a sustainable, low-carbon future. Among the most discussed are carbon taxes and subsidies on renewable energies. Carbon taxes would make emissions costly in financial terms and, in this way, incentivize businesses and people to find cleaner ways.

Both policies have been widely adopted despite receiving considerable criticism: Carbon taxes have been criticized for perhaps merely allowing businesses to continue polluting by passing the cost on to consumers, while renewable energy subsidies have been questioned as to their long-term financial viability. This essay compares the peculiar effects of carbon taxes and subsidies for renewable energy, assesses their relative efficacy in dealing with climate change, and discusses possible alternatives that could be used to overcome the concerns associated with these policies.

2. Manuscript

2.1. Overview of Carbon Taxes

A carbon tax is one of the policy tools that was specifically developed with the goal of decreasing emissions of the main greenhouse gases by placing a price on the carbon content of various fossil fuels. At the core of a carbon tax implementation lays an assumption: that businesses and people, due to financial penalties for carbon pollution, would seek to decrease it. For one, the higher the carbon-emission tax, the stronger the financial incentive to make an energy switch to cleaner, renewable energy or more technologically efficient sources [1]. This is in accordance with what Palley (2011) says. In practice, the carbon tax is imposed based on the carbon content of the fuel at the extraction or consumption point. It can be applied to coal, oil, and natural gas, where the tax rate depends on the carbon dioxide each fuel produces upon combustion. The aim is to

  DOI: 10.25236/icfmhss.2025.017

internalize the environmental cost associated with carbon emissions, which are usually externalities that do not factor into the market price of fossil fuels.

Several countries have, nevertheless, successfully attempted to implement carbon taxes, and especially European ones. Sweden introduced a carbon tax as far back as 1991, and is generally held out as one of the most successful models in the world. According to the Swedish government, CO2 emissions have been reduced by some 25% since the imposition of the tax, while the economy has nevertheless continued to grow [2].

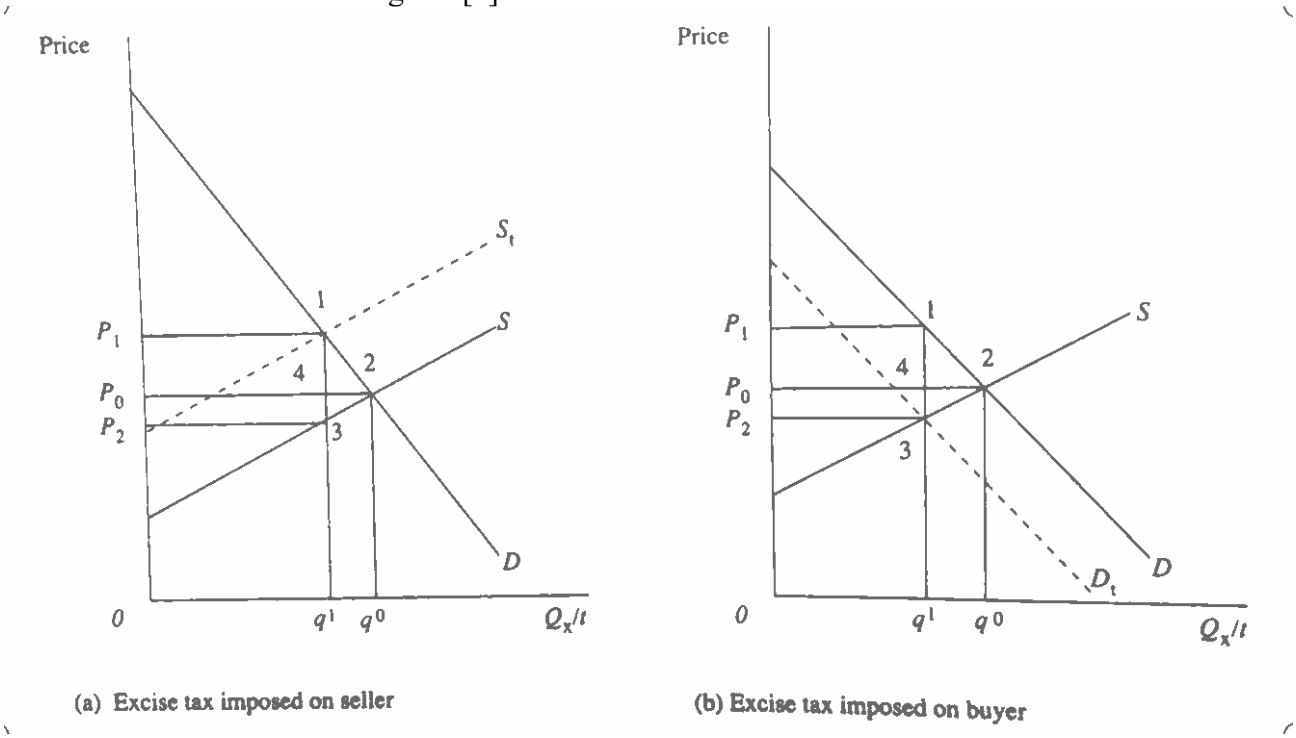

Figure 1: Legal and economic incidence of taxation

Despite their potential, there are plenty of criticisms against carbon tax. Critics say carbon tax may be too weak in ensuring deep cuts in the emission of gases, at least in industries where there is a tight embedment of carbon-intensive technologies (Figure 1). Carbon taxes can result in carbon leakage, where the businesses relocate to countries that are not imposing such taxes. This could undermine the global effectiveness of the policy approach. By 2050, global energy use increases nearly 50%, driven by non-OECD economic growth and population (Figure 2).

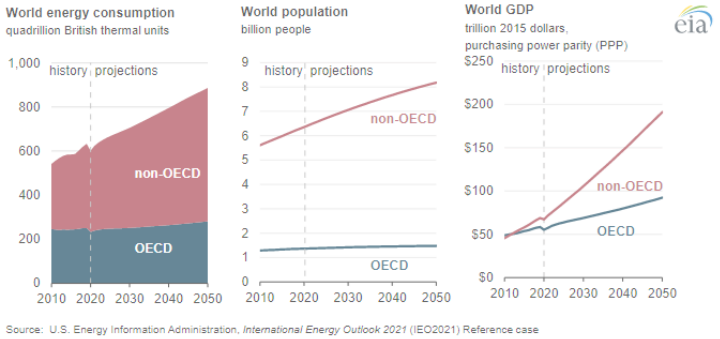

Figure 2: By 2050, global energy use increases nearly 50%, driven by non-OECD economic growth and population

2.2. Overview of Subsidies for Renewable Energy

Subsidies for renewable energy are a type of financial incentive granted by a government to develop and improve clean energy technologies. In opposition to carbon taxes, which rely on the punishment of carbon-intense activities, renewable energy subsidies target the reduction in the costs of producing renewable energy, making those technologies more competitive with fossil fuels.

Support can come through direct cash grants, tax breaks, feed-in tariffs, and price guarantees to the firms producing renewable energy[3].

Subsidies for renewable energy primarily aim to accelerate the low-carbon transition by making resources from such emerging alternatives as wind, solar, hydroelectric, and geothermal energy more viable. Subsidies make it economically viable for energy producers to invest in renewable energy infrastructure that may otherwise be prohibitively expensive owing to high initial capital costs or technological limitations [4]. The subsidy-driven programs develop a transition more effectively compared to the carbon taxes or cap-and-trade. Perhaps the best example could be the successful subsidy-driven program which is Germany's Energiewende or energy transition, and since the early 2000s, when this process of switching began to occur, investment into solar and especially wind started, placing it among the world leaders in the amount of clean energy. Similarly, renewable energy subsidies allowed China to become the largest producer of solar panels, hence playing a leading role in clean energy markets worldwide[3].

While these subsidies have driven the growth of renewable energy, a variety of challenges still confront renewable energy subsidies. One of the major concerns is the financial viability of such subsidies. It is hard for governments to maintain large-scale and long-term renewable energy subsidies, especially in developing economies, during periods of economic slowdown[2].

2.3. Unique Effects of Carbon Taxes vs. Subsidies for Renewable Energy

2.3.1. Effectiveness in Reducing Emissions

While carbon tax and renewable energy subsidies are set to cut down on greenhouse gas emissions, they achieve their objective using different methods. Carbon tax punishes carbon use directly, thereby offering a financial motive to the companies and consumers for cutting down carbon emission. The tax raises the price of consumption of fossil fuel, hence promoting the adoption of technologies that are efficient in energy use and other cleaner sources of energy [2]. In this way, carbon taxes can be effective in bringing down emissions through a wide array of sectors, from transportation to manufacturing. There are examples of countries such as Sweden, which has witnessed a reduction in its emissions amidst economic growth following the implementation of carbon tax[2]. Figure 3 shows reducing emissions by 2050 through six technological avenues.

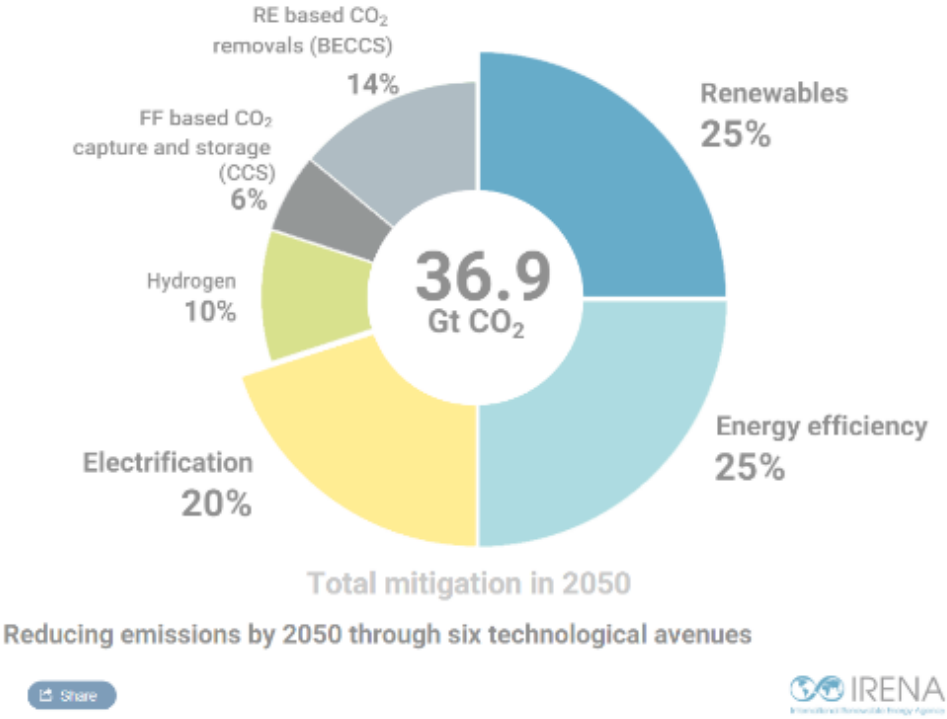

Figure 3: Reducing emissions by 2050 through six technological avenues

However, the effectiveness of carbon tax can be restricted by only the tax rate and scope as well as available alternatives. Because if the tax rate stays too low, it then cannot provide adequate incentive within firms to behave differently and change, in particular industry sectors where technologies are deep-seated, like coal-based power plants[5].

On the other hand, subsidies for renewable energy directly tackle the problem of emissions through the promotion of clean energy technologies. By reducing the cost of renewable energy, subsidies spur investment in solar, wind, and other low-carbon energy sources, thereby reducing reliance on fossil fuels [4]. These subsidies have indeed been instrumental in the rapid growth of renewable energy, especially in countries where fossil fuels have been the traditional source of energy. However, subsidies will not work if grid infrastructure or storage technology cannot keep pace with the growing demand for renewable energy [3].

2.3.2. Long-term Sustainability and Economic Impact

Apart from the question of emission reduction, there is one more critical issue: the question of long-term sustainability. Generally speaking, the carbon tax is seen to be more long-term sustainable since it generates revenue for governments that could be used either to finance environmental programs or reduce other types of taxation. The general problem of an economy with a carbon tax is the questioning of economic fairness, and concerns about carbon leakage-that is, businesses moving their production to countries that have minimum or no carbon taxes [6]. On the contrary, subsidies to renewable energies typically create a continuous public expense in periods when it is more difficult for the public finances to afford this expense, given the overall negative situation with respect to economic performance [2].

2.4. Criticisms and Challenges of Carbon Taxes and Renewable Energy Subsidies

2.4.1. Criticisms of Carbon Taxes

While carbon taxes are vaunted for being economically efficient and effective in stimulating reductions, they suffer from major criticisms. Of these, perhaps the most important concern involves the truly regressive nature of the carbon tax. Because households with low incomes tend to spend more of their incomes on commodities with high embedded energy, higher carbon prices hit the poor harder and could thus be used to reinforce social inequality [3]. Some would say because of this, carbon taxes can be offset with rebates or redistribution schemes, but this does not always solve the problem, especially in highly unequal countries [7].

Another criticism is that it can lead to carbon leakage, where businesses would simply shift to countries with no carbon taxes, hence weakening the effectiveness of such a policy in bringing down global emissions [6]. This is particularly a problem in industries where carbon taxes greatly raise the cost of production, making it easier for businesses to shift operations to regions with lower environmental regulations. Carbon taxes, however, can be harmful to domestic industries, which often face competitive disadvantages, particularly in the globalized market where trade relationships may already be strained [2].

2.4.2. Criticisms of Renewable Energy Subsidies

While renewable energy subsidies have, no doubt, been an efficient tool in promoting the development of clean energies as well, they also present their set of drawbacks. Criticisms include, for example, the problem of the financing of the subsidy provided therein [8]. In most countries around the world, this financial cost for the subsidies being given may become overly encumbering for their state budgets if they do not phase out their subsidy regimes as the technologies used by these alternatives to fossil fuels evolve in terms of their economic efficiency [2]. For instance, during the initial years of Germany's Energiewende, when the subsidy cost of solar and wind energy was added to the price of electricity that consumers had to pay, public resistance arose, and political pushback came along.

Subsidies for renewable energy sources also have the potential to cause market distortions, especially if they are not finely tuned. Sometimes, subsidies may favor one technology over another

and therefore may slow down the development of the most efficient or innovative solution in that particular area [3].

3. Application and Analysis in China

In the context of global efforts to address climate change, China has been taking a series of measures to reduce carbon emissions and promote the development of renewable energy [9]. Carbon tax and renewable energy subsidies are two important policy tools in this regard. This paper aims to analyze the implementation status and policy effects of these two policies in China.

3.1. Implementation of Carbon Tax in China

3.1.1. Policy Framework

As of now, China has not yet implemented a national unified carbon tax. However, China has been exploring and piloting related policies. For example, the carbon emissions trading system is an important market - based tool for carbon emission control. The launch of the national carbon emissions trading market in 2021 is a significant step. Although different from a carbon tax, it also exerts pressure on high - carbon emission enterprises by setting carbon emission quotas and allowing trading of emission allowances [10]. In addition, some local governments have carried out research and exploration on carbon - related tax policies at the local level, laying the groundwork for the possible implementation of a national carbon tax in the future.

3.1.2. Industry Impact

For energy - intensive industries such as the power, steel, and cement industries, the potential implementation of a carbon tax will have a profound impact. These industries are major carbon emitters. A carbon tax would increase their production costs, forcing them to seek ways to reduce carbon emissions. For example, power plants may accelerate the transformation from coal - fired power generation to cleaner energy sources such as natural gas - fired power generation or invest more in carbon capture and storage technologies.

3.2. Implementation of Renewable Energy Subsidies In China

3.2.1. Subsidy Policies and Their Evolution

China has introduced a series of renewable energy subsidy policies. Since 2006, the feed - in tariff (FIT) policy has been implemented. Under this policy, different types of renewable energy power generation, such as wind power and photovoltaic power generation, are given fixed electricity price subsidies. This policy has effectively promoted the rapid growth of the renewable energy power generation industry. For example, China has become the world's largest installer of wind and photovoltaic power generation.

In recent years, with the development of the renewable energy industry, the subsidy policy has also been adjusted. The subsidy model is gradually shifting from fixed - price subsidies to more market - oriented subsidy models. For example, in the field of photovoltaic power generation, the "subsidy - free on - grid" policy has been promoted in some areas, encouraging enterprises to reduce costs through technological innovation and scale expansion to participate in market competition without relying on subsidies.

3.2.2. Support for Different Renewable Energy Sectors

Wind Power: Subsidies have played a crucial role in promoting the large - scale development of wind power. From the initial support for the construction of onshore wind farms to the current exploration and development of offshore wind power, subsidies have continuously guided capital to flow into the wind power industry. This has promoted the improvement of domestic wind power equipment manufacturing technology and the reduction of costs.

Photovoltaic Power Generation: The subsidy policy has also strongly supported the photovoltaic power generation industry. It has not only promoted the large - scale construction of photovoltaic

power plants but also driven the development of the entire photovoltaic industry chain, from the production of silicon materials to the installation and application of photovoltaic modules. In addition, subsidies for distributed photovoltaic power generation have also encouraged the participation of more small - and medium - sized investors and promoted the popularization of photovoltaic power generation at the grass - roots level.

3.3. Policy Effects Analysis

3.3.1. Carbon Tax Policy Effects

Emission Reduction Potential: Although a national carbon tax has not been implemented, studies based on simulations and international experience show that a carbon tax can effectively reduce carbon emissions. By increasing the cost of carbon emissions, enterprises will be motivated to adopt cleaner production technologies, improve energy efficiency, and reduce carbon dioxide emissions. For example, international experience shows that a certain increase in the carbon tax rate can lead to a significant reduction in carbon emissions in relevant industries.

Impact on Energy Structure Adjustment: A carbon tax can also promote the adjustment of the energy structure. It makes high - carbon energy sources relatively more expensive, thus promoting the substitution of low - carbon or zero - carbon energy sources such as renewable energy. This is conducive to China's goal of increasing the proportion of renewable energy in the energy mix.

3.3.2. Renewable Energy Subsidy Policy Effects

Increase in Renewable Energy Installed Capacity: The most direct effect of renewable energy subsidy policies is the significant increase in renewable energy installed capacity. According to relevant data, from 2006 to the present, the installed capacity of wind power and photovoltaic power generation in China has increased exponentially. This has made a huge contribution to reducing China's dependence on traditional fossil energy and promoting the low - carbon transformation of the energy structure.

Driving Industrial Development: Subsidies have also driven the development of related industries. For example, in the renewable energy equipment manufacturing industry, a large number of domestic enterprises have grown and become competitive in the international market. The development of the industry has also created a large number of employment opportunities, from R & D, manufacturing to installation and maintenance.

Environmental Benefits: The expansion of renewable energy power generation has brought obvious environmental benefits. It has significantly reduced carbon dioxide emissions, as well as emissions of other pollutants such as sulfur dioxide and nitrogen oxides, which is conducive to improving air quality and mitigating the impact of climate change.

3.4. Challenges and Solutions

3.4.1. Challenges in Carbon Tax Implementation

Policy Coordination: If a carbon tax is implemented in the future, it will need to be coordinated with existing environmental protection policies, such as the carbon emissions trading system and environmental protection taxes. Otherwise, there may be problems of double - taxation or inconsistent policy effects.

Impact on Enterprises: The implementation of a carbon tax will increase the costs of enterprises, especially for some small - and medium - sized enterprises with weak profitability, which may face greater operational pressure. How to balance emission reduction goals and the survival and development of enterprises is a challenge.

3.4.2. Challenges in Renewable Energy Subsidy Policies

Subsidy Gap: With the large - scale development of renewable energy, the subsidy gap has gradually emerged. The amount of subsidy funds required has exceeded the original budget, which has put pressure on the financial system. For example, in the field of photovoltaic power generation, the subsidy arrears problem has affected the enthusiasm of some enterprises.

Sustainable Development of the Industry: As the subsidy policy is gradually withdrawn, whether the renewable energy industry can achieve sustainable development through independent cost reduction and market competitiveness improvement is still a concern. Some enterprises may be overly dependent on subsidies and lack the ability to adapt to market - oriented competition.

3.4.3. Solutions

For Carbon Tax: Strengthen policy research and coordination. When formulating a carbon tax policy, fully consider its connection with existing policies to ensure the overall effectiveness of the policy system. At the same time, for enterprises affected by the carbon tax, some transitional support policies can be introduced, such as tax exemptions or reductions for a certain period for small - and medium - sized enterprises that actively carry out emission reduction actions.

For Renewable Energy Subsidies: In terms of subsidy funds, explore diversified financing channels, such as issuing special bonds for renewable energy development, to alleviate the subsidy gap problem. In promoting the sustainable development of the industry, strengthen support for scientific research and technological innovation in the renewable energy field, encourage enterprises to reduce costs through technological progress, and improve the market competitiveness of renewable energy products.

3.5. Remarks

Carbon tax and renewable energy subsidies are important policy means for China to achieve carbon emission reduction and energy structure transformation. Although the carbon tax has not been fully implemented, its exploration and related market - based tools such as the carbon emissions trading system have already had an impact on carbon emission control. Renewable energy subsidy policies have achieved remarkable results in promoting the development of renewable energy, but they also face some challenges. In the future, China needs to continuously improve relevant policies, strengthen policy coordination, and promote the joint action of carbon tax and renewable energy subsidies to better achieve the goals of carbon peaking and carbon neutrality and promote the sustainable development of the economy and society.

4. Conclusion

In the end, carbon tax and subsidies for renewable energies both have a place of importance in the global crusade against climate change due to their different sets of challenges and advantages. Carbon tax is very effective in putting economic incentives on emission cuttings across a wide scale of sectors by raising costs of carbon-intensive activities. However, its effectiveness depends much on the tax rate set and the availability of substitutes at affordable rates.

In the end, a combination of both approaches, among other mechanisms such as cap-and-trade systems, carbon dividends, and direct investment in green technologies, may turn out to be the most effective way to deal with climate change. Policymakers will have to balance the strengths and weaknesses of each approach carefully to ensure that together they form a sound and fair route toward a low-carbon sustainable future.

References

[1] Martelli, E., Freschini, M., and Zatti, M. ‘Optimization of renewable energy subsidy and carbon tax for multi energy systems using bilevel programming’, Applied Energy, 2020, 267, pp. 115089

[2] Kregel, J. ‘Minsky's ‘Cushions of Safety', Systemic Risk and the Crisis in the Subprime Mortgage Market’, Finance & Bien Commun, 2008, No 31-32, (2), pp. 51-59

[3] Wray, L. R. "Modern money theory: A primer on macroeconomics for sovereign monetary systems.(2012 edition) University of Missourt-Kansas City". 2012.

[4] van Staveren, Irene. "Chapter 2: Hyman Minsky on Financial Crises." Alternative Ideas from 10 (Almost) Forgotten Economists. Cham: Springer International Publishing, 2021. 31-47.

[5] Palley, T.I. ‘A Theory of Minsky Super-cycles and Financial Crises*’, Contributions to Political Economy, 2011, 30, (1), pp. 31-46

[6] Graeber, David. Debt: the first 5,000 years, updated and expanded. Melville House, 2014.

[7] Taylor, L., and O'Connell, S.A. ‘A Minsky Crisis*’, The Quarterly Journal of Economics, 1985, 100, (Supplement), pp. 871-885

[8] Chisari, O. O., & Miller, S. J. CGE Modeling: The Relevance of Alternative Structural Specifications for the Evaluation of Carbon Taxes' Impact and for the Integrated Assessment of Climate Change Effects: Simulations for Economies o. Inter-American Development Bank. https://doi.org/10.18235/0009242. 2015.

[9] Ministry of Ecology and Environment. (2024). "Reply Letter on Proposal No. 01927 (Resource and Environment Category, No. 137) of the Second Session of the 14th National Committee of the Chinese People's Political Consultative Conference".

[10] Guangxi Zhuang Autonomous Region Tax Service of the State Taxation Administration. (2024). "Research on Improving China's Green Tax System".