Impact of Energy Transformation on China's Greenhouse Effect under Carbon Peak and Carbon Neutral Targets

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Abstract: The greenhouse effect is a global warming (GW) phenomenon caused by human activities. Therefore, it has become a global concern to reduce greenhouse gas emissions and control climate warming. This article aims to study how to analyze and study the impact of ET (Energy Transformation) on China's greenhouse effect based on the Stochastic Impacts by Regulation on Population, Affluence, and Technology (STIRPAT) model, and to comb the current situation and trends of carbon emissions (for the convenience of the following text, carbon emission is abbreviated as CE) in China. The focus of this study is on the impact of China's ET on the greenhouse effect, which is to study whether the ET can effectively reduce the intensity of the greenhouse effect and the rate of temperature rise in China with the existing energy structure and industrial structure unchanged. This article analyzed the scale and intensity of China's CEs from 1995 to 2020, and understood that during the period 2003-2012, China's CEs grew very rapidly. In 2020, China's CEs reached 10.273 billion tons. In addition, through the analysis of CEs prediction under three different scenarios, this article found that under the baseline scenario, China's future CEs scale would continue to grow. Under the planning scenario, it was expected that the CE scale would reach 137,541 million tons and 143,817 million tons respectively in 2030 and 2060. Under the regulatory scenario, it would reach a peak in 2030 and then show a downward trend. In 2050, the scale of CEs would begin to maintain a balance, and under the regulatory scenario, the greenhouse effect would also be significantly reduced.

Keywords: Greenhouse Effect, STIRPAT Model, Carbon Peak, Carbon Neutralization, Energy Transformation

1. Introduction

China has become the world's largest CO2 emitter and the world's largest greenhouse gas emitter. Although China has actively promoted the adjustment of its energy structure and the optimization and upgrading of its industrial structure, the main mode of energy production and consumption in China is still traditional fossil energy, with coal as the main power source. The development concept should change the fossil energy-based economic growth model and focus on promoting low-carbon energy to replace fossil energy. In terms of policy measures, people should vigorously develop power generation from non-fossil energy sources and control total coal consumption. At the same time, clean energy industry and new energy industry should be developed. Therefore, in terms of macro policies, there is a need to establish a sound policy system and long-term mechanism.

With the continuous development of society, research on the greenhouse effect has gradually increased. Kweku Darkwah Williams concerned with greenhouse gases and their impact on GW, the existence of which makes the earth a comfortable place to live, and he also revealed the importance of greenhouse gases on the warming of the earth [1]. Li Tao projected and managed to synthesize transparent wavelength-selective metal-polymer hybrid films with a low emissivity in the infrared range of less than 0.1. He believed that his thin film was expected to be widely used, thereby saving a lot of energy for indoor heating [2]. Harris Sara E. evaluated undergraduate students' performance on the greenhouse effect before and after a 30-minute constructivist class based on a concept sketch generated by the students [3]. Handayani Rif'ati Dina collected data through an open-ended questionnaire with 140 students and analyzed it inductively to determine perceptions and patterns. The results showed that five harmful environmental behaviors were identified by the students as contributing to GW: use of fossil fuels, deforestation, aerosol use, littering, and air pollution. These five activities contribute to GW by producing the greenhouse effect and depleting the ozone layer [4]. Zhou Tianjun described the progression of climate science over the past 200 years and highlighted landmark developments in advancing the understanding of climate change. Starting with the discovery of the greenhouse effect to the formation of Earth system science, the pillars of modern climate science in the context of disciplinary development were further discussion [5]. Although these studies have promoted the greenhouse effect to some extent, they have not been studied in combination with actual conditions.

At the same time, the STIRPAT model has gradually attracted widespread attention from the academic community. Ainy Noer Sarifah aimed to build learning media for the green box effect simulator to assist in understanding the concept of the greenhouse effect, which has implications for the application of the STIRPAT model [6]. Umami Fauzah aimed to develop a modeling of the greenhouse effect and then predict the greenhouse effect over time using an autoregressive integrated moving average approach, which would facilitate the STIRPAT model's means of use [7]. Chung Sueim intended to identify whether secondary school students can appreciate GW and greenhouse effects and interpret them in terms of global radiation balance, which would deepen the application of STIRPAT model in greenhouse effects [8]. Stannard Warren proposed a modified model that showed that increased atmospheric emissivity enhanced the ability of the atmosphere to radiate heat into space, overcoming the cooling effect that leads to net planetary cooling. Considering this result, it is necessary to revise the GW model for the greenhouse effect, which has reference significance for the STIRPAT model [9]. Chen Wei's observation and analysis indicated that in the mid-1990s, some extreme temperatures in China experienced significant changes. The atmospheric ocean mixed layer coupling model resulting from changes in greenhouse gas concentrations and anthropogenic aerosol emissions truly reproduced the general spatial patterns and amplitudes of thermal and cold extreme changes observed in the mid-1990s, which has reference significance for the selection of factors in the STIRPAT model [10]. Although these research methods are innovative, a large amount of experimental data is required to prove the reliability of the methods.

This article first analyzed the modeling methods for the impact of ET on China's greenhouse effect, including CEs and greenhouse effect, ET, and STIRPAT model. Secondly, this article gave a detailed description of China's CE trends. Finally, this article analyzed the CE scale prediction under three different scenarios.

2. Modeling Method for the Impact of ET on China's Greenhouse Effect

2.1 CEs and Greenhouse Effect

CEs are closely related to the greenhouse effect. They are the most important factor causing the greenhouse effect, and their main source is human factors, especially the consumption of mineral energy [11]. CEs can generate greenhouse gases such as CO2, methane, hydrogen, and other greenhouse gases that can exist in the atmosphere for centuries. These gases can significantly increase the amount of CO2 in the atmosphere, causing a greenhouse effect [12-13].

CO2 is a greenhouse gas that mainly comes from the exhaust gas emitted during the combustion of fossil fuels, mainly from industrial production and residential life. The greenhouse effect is a global climate change caused by an increase in CO2 content in the atmosphere. Its main content is global climate change caused by rising temperatures, increased heavy rainfall, and heat absorption by the ocean [14].

Fundamentally, the greenhouse effect is like a magnetic field that protects CO2, preventing hot gases from escaping from the atmosphere and maintaining a constant surface temperature. However, when the greenhouse effect reaches a certain level, it would cause the Earth to warm up.

The extensive use of fossil energy sources such as coal and oil in recent centuries has led to the release of large amounts of greenhouse gases such as CO2 [15]. They are known as the "greenhouse effect" because they can well transmit visible light from the sun and absorb long waves reflected from the earth, causing a rise in global temperatures. The problems of precipitation redistribution, glaciers, permafrost melting, and sea level rise caused by climate change not only have a serious impact on the ecological balance of nature, but also have a serious impact on people's survival and living environment.

To mitigate the greenhouse effect, there are three main methods:

It can be seen that the first step is to reduce CEs. The development and utilization of renewable resources can effectively reduce the consumption of fossil fuels, thereby reducing greenhouse gas concentrations, and mitigating GW. The international community should strengthen cooperation with countries in implementing rules related to global CEs control and promote the implementation of various international cooperation projects to address climate change.

Secondly, using carbon neutralization technology to "absorb" the CO2 released into the air can not only enhance the photosynthetic efficiency of plants, but also reduce greenhouse gases.

Finally, minimizing the emission of harmful substances is of great significance for curbing GW and improving the level of global climate change.

Therefore, it is necessary to increase research efforts on global climate change, and adopt corresponding effective CE control and carbon neutralization technologies, thereby achieving effective control of the greenhouse effect.

2.2 Energy Transformation

At the current rate of growth, China's goal of achieving carbon peaking around 2050 and carbon neutrality by 2060 would be advanced to around 2050. The current ET discussed by the international community is actually a transformation of the energy structure. Energy structure refers to the proportion of various types of energy consumption. The current ET would focus on a significant decrease in the proportion of mineral energy (coal, oil, and natural gas) in the energy structure, while the proportion of renewable energy would significantly increase. In other words, people would rely less on mineral energy and more on clean electricity.

This article summarizes the reasons for the current trend of ET into three aspects:

The biggest reason for this phenomenon is not only the requirements for environmental protection, but also the requirements for global climate. Mineral resources such as oil and coal generate a large amount of pollution and CO2, and in the long run, the environment would be overwhelmed.

The second and crucial reason is that the cost of renewable energy is greatly reduced. It is well known that solar and wind energy are currently the main sources of renewable energy, and the utilization rate of this type of energy would greatly increase.

The third reason is the development of electric vehicle technology. The most important of these is battery technology. It is reported that the price of batteries decreased by 73% between 2010 and 2016. Therefore, electric vehicles are still highly competitive in the market. The report also specifically mentioned that China is vigorously promoting electric vehicles, and the impact of this policy is not limited to China, but may even spread to various parts of the world, creating a certain squeezing effect on internal combustion powered vehicles. Other technologies, such as hydrogen batteries, and other more advanced technologies, pose a significant threat to conventional internal combustion powered vehicles.

Based on the impact of the above aspects, it can be predicted that in the long run, fossil energy, especially oil, would gradually withdraw from the dominant position of world energy. Currently, China's energy structure is transforming from traditional resources to renewable and low-carbon energy.

China's ET has two aspects:

It can be seen that the first is the transition from fossil energy to renewable energy, and the second is the transition from energy consumption to clean energy. Globally, fossil energy is the main renewable energy, but China's share of fossil energy in the world is still high. Currently, the proportion of coal in China is still high, and it is still necessary to continuously control fossil energy consumption.

In different stages of development and different types of countries, the impact of emission reduction on greenhouse gas emissions varies greatly. Globally, CO2 emissions are mainly affected by factors such as population and economic growth. Among them, there is a strong correlation between economic growth and greenhouse gas emissions, while there is a weak correlation between population size and greenhouse gas emissions. Achieving carbon peak and carbon neutrality is a systematic project that requires overall planning, overall design, and comprehensive measures. It requires the full cooperation of governments at all levels and all sectors of society, and is a long and difficult process.

2.3 STIRPAT Model

In 1971, a scholar first proposed the Impact-Population-Affluence-Technology (IPAT) model, with the specific formula as follows:

$$I = PAT \quad (1)$$

Among them, I refer to environmental factors; P is a demographic factor; A is an economic factor; T is a technical factor. However, this model also has some shortcomings, that is, there is an equal proportion of influence between various influencing factors and environmental factors. Although it can reflect the impact of population, economy, technology, and other factors on the environment, it is not consistent with reality.

Based on the IPAT model, some researchers have conducted in-depth research on it, and proposed the STIRPAT model, and addressed the limitations of the IPAT model. The specific formula is as follows:

$$I_t = aP_t^b A_t^c T_t^d \delta_t \quad (2)$$

Among them, the year is t; the population factor is P; the economic factor is A; the technical factor is T; A is a constant; b, c, and $d$are coefficients of P, A, and T, respectively; δ_t represents the regression residual term. In order to facilitate the determination of the role of various influencing factors in the formula, and to make the regression results easier to understand and more concise, the logarithm is taken on both sides of Formula (2). The specific formula is as follows:

$$In(I_t) = a + b\ln(P_t^b) + c\ln(A_t^c) + d\ln(T_t^d) + \delta_t \quad (3)$$

From Formula (3), it can be seen that the IPAT model is a special STIRPAT model. When the coefficients of all influencing factors are 1, it is the IPAT model. In addition, the STIRPAT model also has the feature of adding other factors related to the three major elements to the pattern. Therefore, the model proposed in this article has good adaptability, greatly expanding the research on the factors affecting CEs.

This article attempts to add some other variables to the STIRPAT model to better identify the main CE factors in China. The inverted U-shaped environmental Nietzsche curve indicates that the secondary factors of economic factors have an important impact on environmental quality and CEs. Some scholars classify energy related factors as technical factors such as energy consumption density, while others classify energy factors as a single factor and point out that these factors play an important role in China’s CEs. In this article, only the energy factor is considered as an important influencing factor. Based on the research of other scholars, this paper mainly start from two aspects. One is to add the secondary term of economic factors, and the other is to expand the content of the original influencing factors, or add new influencing factors. The expanded STIRPAT model is as follows:

$$\ln(CE_t) = a + b\ln(P_t) + c\ln(A_t) + d(\ln(A_t))^2 + e\ln(T_t) + f\ln(E_t) + g\ln(O_t) + \delta_t \quad (4)$$

Among them, *t* still represents the year; *b*, *c*, *d*, *e*, *f*, and *g* are coefficients of the above factors; *a* is a constant term. *CE* refers to the scale of CEs. *P* is a demographic factor that can be expressed in terms of population size, aging, urbanization, and other factors. "*A*" refers to economic factors, which can be expressed in terms of GDP, per capita GDP, and the proportion of the secondary and tertiary industries. *E* is an energy element that can be represented by indicators such as energy consumption, energy intensity, and energy structure. *O* is introduced into the model as some new and other factors. In the process of establishing the model, a variable under each factor is introduced into the model, and the impact degree of each factor is finally found.

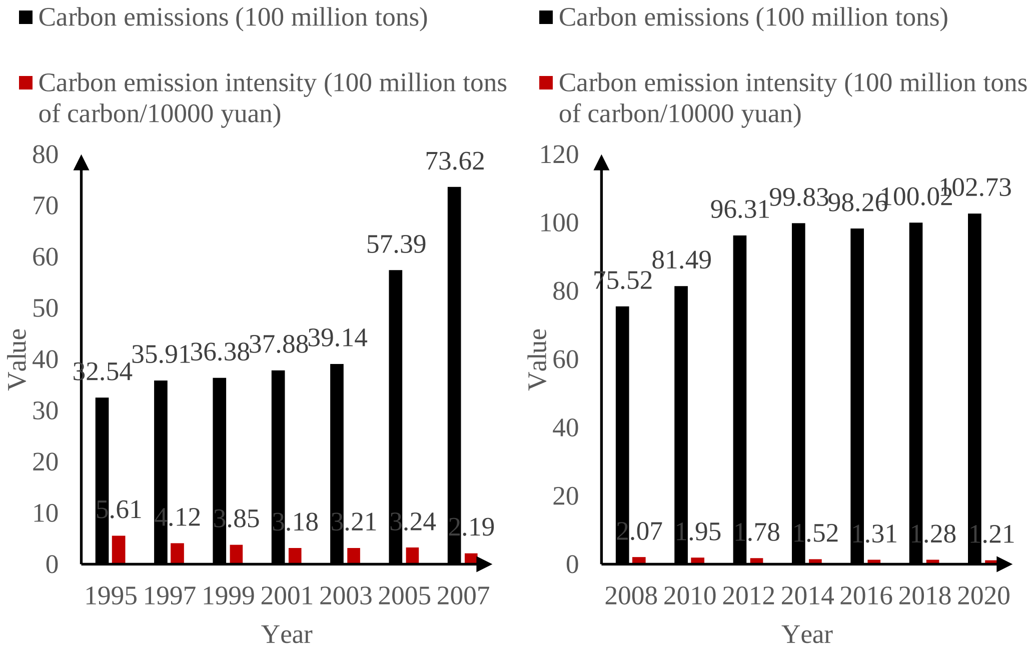
In summary, the IPAT model can only be compared, and the STIRPAT model makes up for its shortcomings. Currently, many scholars have conducted a large amount of research and application on the STIRPAT model in the environmental field. Therefore, in China's research on the factors affecting the size of CEs, this model can be used for regression analysis to obtain the impact of various factors on the size of CEs. Based on this, this article expands the STIRPAT model based on China's actual situation and previous research results, and on this basis, selects China's main influencing factors as independent variables. Through quantitative means, it examines the impact of these factors on China's main CEs, thereby providing theoretical support for the prediction of China's main CEs.

3. Experiment and Evaluation of the Impact of ET on China's Greenhouse Effect

3.1 China's CE Trend

China is currently the largest country in the world in terms of CEs, and in order to maintain long-term balance, the scale of CEs would continue to increase. China has great pressure and strong sense of social responsibility in achieving low-carbon goals and achieving sustainable development. From the perspective of China's economic development level and industrial structure, CE intensity can well reflect China's economic development level and economic development level.

The scale and intensity of China's CEs from 1995 to 2020 are shown in Figure 1.



(a) 1995-2007 (b) 2008-2020

Figure 1. China's CE scale and intensity from 1995 to 2020

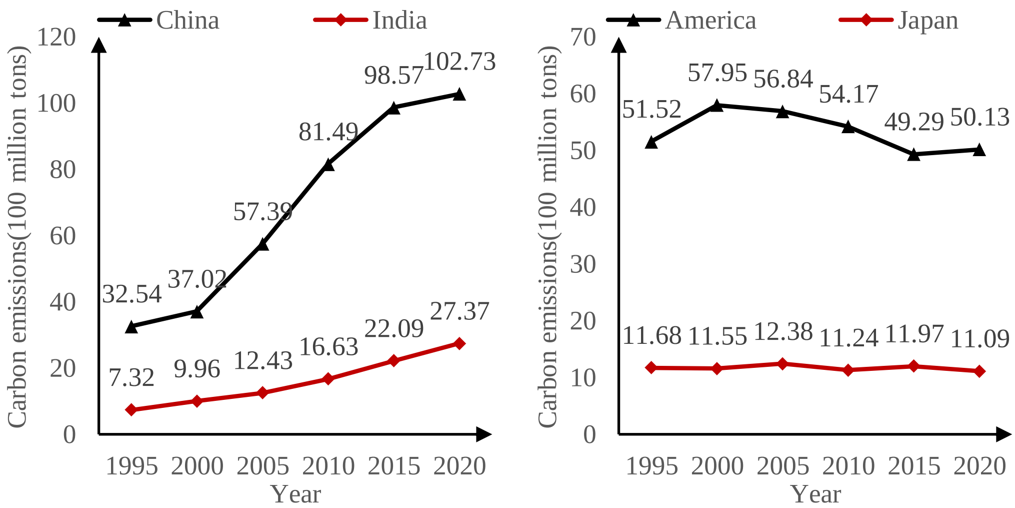
As can be seen from Figure 1 (a), in 1995, China's CEs scale and intensity were 3.254 billion tons and 561 million tons of carbon per 10000 yuan, respectively; in 1999, the two values were 3.638 billion tons and 385 million tons of carbon per 10000 yuan, respectively; in 2003, the two values were 3.914 billion tons and 321 million tons of carbon per 10000 yuan, respectively; in 2005, the two values were 5.739 billion tons and 324 million tons of carbon per 10000 yuan, respectively. As can be seen from Figure 1 (b), in 2008, China's CE scale and intensity were 7.552 billion tons and 207 million tons of carbon per 10000 yuan, respectively; in 2012, the two values were 9.631 billion tons and 178 million tons of carbon per 10000 yuan, respectively; in 2016, the two values were 9.826 billion tons and 131 million tons of carbon per 10000 yuan, respectively; in 2020, the two values were 10.273 billion tons and 121 million tons of carbon per 10000 yuan, respectively.

As can be seen from Figure 1, China's CEs are continuously rising, especially during the period 2003-2012, China's CEs have grown very rapidly. After 2012, the growth rate of China's CEs has slowed down. This is due to the fact that China has embarked on the deployment of CEs rights since 2012, and has set up pilot cities for CEs rights to alleviate the problem of excessive CEs rights in China.

In addition, China's overall CE intensity shows a downward trend, which is contrary to the trend of changes in CE scale. China remains a high carbon energy consumption structure dominated by coal, and on this basis, fundamental reforms are needed to explore new space for reduction. Therefore, China should reduce the intensity of low CEs by optimizing its energy structure and accelerating industrial upgrading.

Figure 2 shows the changes in CEs in countries with relatively high CEs from

1995 to 2020.



(a) China and India (b) United States and Japan

Figure 2. Annual CE scale changes in different countries

As can be seen from Figure 2 (a), in 1995, the annual CEs of China and India were 3.254 and 732 billion tons, respectively, 5.739 and 1.243 billion tons in 2005, and 9.857 and 2.209 billion tons in 2015. As can be seen from Figure 2 (b), in 1995, the annual CEs of the United States and Japan were 5.152 and 1.168 billion tons, 5.684 and 1.238 billion tons in 2005, and 4.929 and 1.197 billion tons in 2015, respectively.

From the data in Figure 2, the CEs of China and India are continuously increasing, but have not yet reached the peak. During this period, the economic growth of the United States and Japan has reached a peak and is in a downward period. Currently, China still uses coal as its main energy source, characterized by high pollution and high CEs. As a developing country, China's energy conservation and emission reduction technology is not mature enough; energy utilization efficiency is not high enough; the application field of clean energy is relatively narrow; CEs are still increasing. Other countries have already achieved industrialization and have passed the period of increasing CO2. With the deepening process of economic globalization and the strengthening of international trade and labor division, developed countries can use cross-border industrial transfer to transfer pollution to developing countries.

China's energy consumption structure is still very unreasonable, with coal as the main high carbon source, while clean energy accounts for a small proportion. Therefore, China's future CO2 emissions would continue to increase over a certain period of time. On the path of China's CEs, China has firmly made a commitment to "reach a carbon peak by 2030 and be carbon neutral by 2060", and has taken corresponding measures on this basis, demonstrating the demeanor of a large country.

Table 1 shows the change data of CEs per capita in China from 1995 to 2020.

Table 1. Per capita CE scale of China from 1995 to 2020

Year	CE scale per capita (ton/person)
1995	2.56
1996	2.59
1998	2.72
2000	2.80
2002	2.96
2004	3.78
2006	4.89
2008	5.43
2010	6.02
2012	6.99
2014	7.14
2016	7.05
2018	7.23
2020	7.35

According to Table 1, in 1995, China's per capita CEs reached 2.56 tons per person, 2.80 tons per person in 2000, 6.02 tons per person in 2010, and 7.35 tons per person in 2020.

In addition, there is a good consistency between China's per capita CEs and the changes in total CEs between 1995 and 2020. The change in CEs per capita in China can be divided into three periods, with 1995-2002 being the first period, during which the growth rate of CEs per capita was relatively slow. The second period is 2002-2012, during which the growth rate of CEs per capita accelerated; 2012-2020 is the third period, during which the per capita CEs remained at a relatively balanced level, but the growth rate slowed down.

3.2 Prediction and Evaluation of CE Scale under Different Scenarios

In the past thirty years, the rapid growth of CEs has led to the intensification of the greenhouse effect, which has brought many negative impacts on people's production and life. Behind the growth of CEs, there are multiple factors such as economy, population, and energy. To accurately estimate China's total CEs and determine how the ET in the context of "dual carbon" would affect China's greenhouse effect, it is necessary to first identify China's total CEs, and then analyze these factors. This article uses the STIRPAT model to conduct a regression analysis of China's CEs from 1995 to 2020, and obtains a regression formula that can reflect the state of China's economic development. This formula can be used to determine the role of various factors in China's economic development, thereby providing a better model for future economic development.

This article would take China's per capita GDP, urbanization rate, energy consumption, etc. from 1995 to 2020 as independent variables to study the impact of economic, demographic, energy, and other factors on the scale of CEs (dependent variable). Using unit root test, multiple collinearity test, significance test, and other methods, the applicability of various influencing factors was tested and verified. The

STIRAT CE scale regression formula is:

$$\ln CE = -4.58 + 0.21 PGDP + 0.54 \ln UR + 0.38 \ln EN \quad (5)$$

Among them, *CE* is the CE scale; *PGDP* is the per capita GDP; *UR* is the urbanization rate; *EN* is the energy consumption.

From the constructed STIRAT model, it can be seen that per capita GDP, energy consumption, and urbanization rate have a significant impact on China’s CEs. Therefore, the baseline assumption is to use a CE that reflects historical trends without regulation or constraints. The predicted values of the relevant data can be obtained by inputting the predicted results of the above three factors into Formula (5) of STIRPAT.

Unlike the baseline scenario, this article would predict CEs from 2025 to 2060 based on the actual change characteristics of variables such as China’s economy, energy, and urbanization. Based on the policy control objectives formulated by relevant government departments, CEs from 2025 to 2060 are predicted. In this case, the variation trend of its CEs should be closer to reality and have more reference value compared to the baseline scenario. On this basis, various factors are simulated, and the simulation results are substituted into Formula (5) of STIRPAT to obtain the predicted values of relevant data under the planning scenario.

The regulatory scenario emphasizes green and sustainable development, and no longer excessively emphasizes economic development as the center and the improvement of urbanization rate. On this basis, with the “dual carbon” as the core, focusing on sustainable development and environmentally friendly development in the future, targeted energy-saving and emission reduction measures are taken to promote green development. On this basis, by analyzing the downward space of each major impact factor and correcting each major factor, people can reduce the average growth rate of GDP per capita, delay the arrival time of the average level of urbanization, and reduce the average level of energy consumption, so that the average level of each major factor reaches its peak before 2030 and reaches its lowest level by 2060, ultimately achieving the goal of “carbon neutral”. On this basis, the predictive data of the influencing factors are substituted into Formula (5) of STIRPAT to obtain the predictive values of the relevant data under the regulatory scenario.

The comparison of GDP per capita under different scenarios is shown in Table 2.

Table 2. Comparison of GDP per capita under different scenarios (yuan)

Year	Benchmark scenario	Planning scenario	Regulation scenario
2025	31973	26798	26887
2030	41975	29783	29782
2035	55342	32945	33480
2040	72945	35367	36218
2045	95761	37389	38156
2050	123642	38764	39187
2055	164879	39756	39344
2060	216894	40678	38942

From Table 2, it can be seen that in 2025, under the baseline scenario, planning scenario, and regulatory scenario, the per capita GDP was respectively 31973 yuan, 26798 yuan, and 26887 yuan; in 2030, the per capita GDP under the three scenarios was 41975 yuan, 29783 yuan, and 29782 yuan respectively; in 2055, the per capita GDP under the three scenarios was 164879 yuan, 39756 yuan, and 39344 yuan, respectively; in 2060, the per capita GDP under the three scenarios was 216894 yuan, 40678 yuan, and 38942 yuan, respectively.

The comparison of urbanization rates under different scenarios is shown in Table 3.

Table 3. Comparison of urbanization rates under different scenarios

Year	Benchmark scenario	Planning scenario	Regulation scenario
2025	68.84%	66.94%	65.48%
2030	73.92%	68.18%	68.19%
2035	78.18%	72.12%	70.32%
2040	81.62%	75.64%	72.03%
2045	84.87%	76.00%	72.45%
2050	86.28%	76.00%	73.59%
2055	88.63%	76.00%	74.68%
2060	89.98%	76.00%	75.21%

From Table 3, it can be seen that in 2025, under the baseline scenario, planning scenario, and regulatory scenario, the urbanization rate would be 68.84%, 66.94%, and 65.48%, respectively; in 2030, the urbanization rates under the three scenarios were 73.92%, 68.18%, and 68.19%, respectively; in 2055, the urbanization rates under the three scenarios were 88.63%, 76.00%, and 74.68%, respectively; in 2060, the urbanization rates under the three scenarios were 89.98%, 76.00%, and 75.21%, respectively.

The comparison of energy consumption under different scenarios is shown in Table 4.

Table 4. Comparison of energy consumption under different scenarios (10000 tons of standard coal)

Year	Benchmark scenario	Planning scenario	Regulation scenario
2025	577671	596482	553128
2030	653784	603148	612573
2035	729756	554842	526481
2040	816479	526481	450189
2045	886481	516254	406482
2050	967524	510232	365496
2055	1029768	510467	364204
2060	1116480	510154	361217

It can be seen from Table 4 that in 2025, under the three scenarios of baseline scenario, planning scenario, and regulatory scenario, the energy consumption would be 5776.71 million tons of standard coal, 5964.82 million tons of standard coal, and 5531.28 million tons of standard coal, respectively; in 2030, the energy consumption under the three scenarios was 6537.84 million tons of standard coal, 6031.48 million tons of standard coal, and 6125.73 million tons of standard coal, respectively; in 2055, the energy consumption under the three scenarios was 10297.68 million tons of standard coal, 5104.67 million tons of standard coal, and 3642.04 million tons of standard coal, respectively; in 2060, the energy consumption under the three scenarios was 11164.8 million tons of standard coal, 5101.54 million tons of standard coal, and 3612.17 million tons of standard coal, respectively.

The comparison of CE scales under different scenarios is shown in Table 5.

Table 5. Comparison of CE scales under different scenarios (100 million tons)

Year	Benchmark scenario	Planning scenario	Regulation scenario
2025	134.372	129.452	126.157
2030	157.985	137.541	136.212
2035	179.341	138.626	134.054
2040	202.673	140.672	131.159
2045	227.484	141.057	127.642
2050	252.992	142.512	123.185
2055	277.844	142.924	123.575
2060	303.421	143.817	123.428

From Table 5, it can be seen that in 2025, the CE scale under the baseline scenario, planning scenario, and regulatory scenario would be 13.4372 billion tons, 12.945.2 billion tons, and 12.615.7 billion tons, respectively; in 2030, the CE scale under the three scenarios was 15798.5 billion tons, 13754.1 billion tons, and 13621.2 billion tons respectively; in 2055, the CE scale under the three scenarios was 277844 million tons, 142924 million tons, and 123575 million tons respectively; in 2060, the CEs under the three scenarios were 303421 million tons, 143817 million tons, and 123428 million tons, respectively.

Under the baseline scenario, China’s CEs would reach 157985 million tons in 2030 and 303421 million tons in 2060, and during this period, its CEs would continue to rise. Overall, under baseline conditions, China’s CEs would slow down, but there is no peak and subsequent downward trend. Therefore, there is a large gap between achieving the carbon peak target and the carbon neutral target. Currently, China has proposed phased emission reduction targets and related plans, and has taken corresponding emission reduction measures. Therefore, the baseline scenario would basically not appear. By analyzing the changes in CEs scale under the baseline scenario, it is possible to better understand the sustained growth trend of China’s CEs without any constraints, thereby providing a scientific basis for China’s future CEs reduction.

In the planning scenario, overall, the CEs in 2030 and 2060 would be 137541 million tons and 143817 million tons, respectively. However, it still cannot meet the goal of achieving a carbon peak by 2030 and starting to decline thereafter. Therefore, under this goal, China’s total CEs in the future cannot meet the predetermined goal. Compared to the baseline scenario, the CE reduction scale of the planned scenario in 2060 is lower than that of the baseline scenario, indicating that the current relevant planning schemes can achieve emission reduction, but still fail to achieve emission reduction targets. Therefore, China should adjust its existing plans based on the differences between planned CEs, carbon peaks, and carbon neutrality, and make targeted adjustments in terms of per capita GDP, urbanization, energy, etc., to enable it to achieve its CE reduction goals faster and mitigate the greenhouse effect.

Under the regulatory scenario, CEs would peak at 13.6212 billion tons in 2030. Thereafter, there would be a downward trend, and by 2050, CEs would remain at a relatively stable level. Obviously, through appropriate adjustments, it is possible to achieve a carbon peak by 2030 and predict China’s total CEs in 2060, thereby providing a basis for better planning for the carbon neutrality goal in 2060. The realization of this goal would also greatly reduce the greenhouse effect.

4. Conclusions

In order to achieve China’s “dual carbon” goal, this article proposed the following suggestions: developing low-carbon or zero carbon energy is one of the effective ways to achieve the greenhouse effect. At the same time, in order to ensure energy security and sustainable development, people should actively develop non fossil energy and renewable energy, and strive to improve the use efficiency of non-fossil energy. Improving per capita energy efficiency can reduce the greenhouse effect. In order to achieve zero CEs, non-fossil fuels such as hydrogen and geothermal energy should be actively developed. During the research process of this article, although the “dual carbon” goal of China has been studied, and the issue of greenhouse effect change has been discussed on this basis. However, due to the constraints of data sources, scientific research level, and personal knowledge level, the prediction of China’s CEs scale still needs further and systematic research.

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