The Core Issue Facing the Green and Low Carbon Development of the Chinese Economy and the Countermeasures

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Abstract: Green development is an important concept based on China's needs and the international situation. Green development will greatly help China choose its path for economic growth. In the newly ratified Paris Agreement, the carbon emission reduction target willingly and determinedly proposed by China is very challenging. It will increase China's cost per unit of carbon dioxide emissions, slow China's economy growth, and set the upper limit for China's carbon emissions in the future. Facing these challenges, China needs to properly conduct carbon allocations under restrictions and promote green and low carbon development of the Chinese economy primarily by reinforcing structural adjustments and optimizing energy structures, upgrading industrial structures, being actively involved in international cooperation on carbon emission reduction and using other positive strategies.

Keywords: green and low carbon development; carbon emission reduction; carbon allocation; structural adjustment; international cooperation

Due to China's extensive pattern of economic growth, its resources and energy have been extensively consumed, and environmental disruptions and ecological degradations have become increasingly serious, approaching or reaching the upper limit of its environmental carrying capacity, and seriously

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undermining China's sustainable economic and social development. Environmental problems that had gradually appeared in developed countries over a period of 100-200 years intensively appeared in China as structural, condensed and complex ones. This further demonstrates the necessity and urgency for the Chinese economy to develop in a green and low carbon way.

If we look at the world's total carbon emissions, we find that the total was 197.86 million tons in 1850, 1,956.58 million tons in 1900, 5,891.71 million tons in 1950, 24,758.12 million tons in 2000, and as high as 33,843.05 million tons in 2012.① The world's total carbon emissions are increasing at an accelerated rate, increasingly heightening the risk of global ecological crisis. Studies show that global climate warming, if not controlled, will cause adverse effects such as climate migration, reduction of grain yields, frequent occurrence of disasters, outbreaks of epidemics, and damage to biodiversity (Stern, 2007). This requires all countries on this planet to take necessary countermeasures to relieve and adapt to the impact of global climatic change. In December 2015, the Parties to the *United Nations Framework Convention on Climate Change* (UNFCCC) unanimously agreed to ratify the Paris Agreement, which says that the Parties to the agreement will strengthen the global response to the threat of climate change, including by holding the increase in the global average temperature to less than 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. In April 2016, 175 countries signed the Paris Agreement at the Headquarters of the UN in New York City. This shows that green and low carbon development has become a global consensus, and the global climate governance system based on the Paris Agreement will become a new dimension of global economic governance as important as the international trade system and the international currency system.

In this context, China needs to not only proactively help promote the green and low carbon development of the world economy and maintain global ecological security, but also proactively transform and change its modes of production and lifestyles, adapt to the new trend of green development, and create new, low carbon competitiveness, so as to lay solid foundations for achieving its Two Centenary Goals under the new international economic order. Based on an understanding of the concept of green development and on the carbon emission reduction target China proposed in the recently ratified Paris Agreement, this paper tries to use relevant economic concepts to analyze the challenges and core issues facing the green and low carbon development of the Chinese economy, and then proposes specific countermeasures.

1. China's carbon emission reduction target and the challenges

1.1 China's carbon emission reduction target

For a long time, China has paid great attention to global climatic change. On the one hand, China has been actively involved in international cooperation on responding to global climatic change. On the other hand, China deems green and low carbon development as an important part of the promotion of its ecological progress and a major strategy for its economic and social development. At the 2009 Copenhagen Summit (COP15), China announced that it would "cut CO_2 emissions per unit

① See CAIT–WRI's Climate Data Explorer.

of GDP by 40%-45% below 2005 level by 2020, increase the share of non-fossil energy in primary energy consumption to around 15% by 2020, increase forest coverage by 40 million hectares by 2020 from the 2005 level, and increase forest stock volume by 1.3 billion cubic meters by 2020 from the 2005 level." To this end, during its 12th Five-Year Plan period, China issued and proactively implemented the *Work Plan for Controlling Greenhouse Gas Emissions during the 12th Five–Year Plan Period*, the *Comprehensive Work Plan for Energy Conservation and Emission Reduction for the 12th Five Year Plan Period*, and *the 12th Five–Year–Plan for Energy Conservation and Emission Reduction*, to promote carbon emission reductions through effective policies and measures.

During the 2014 APEC summit, China and the US, the world's two largest carbon emitters in 2013, issued the *China–US Joint Announcement on Climate Change* at the United Nations Climate Conference in Paris in 2015 (COP21). As the Paris Agreement would come into force only when 55 countries contributed to at least 55% of total global emissions ratify the deal, and China and the US contributed around 40% of total global emissions, the Joint Announcement made it possible for the Paris Agreement to be ratified.

At the 2015 Paris Climate Conference, China, based on its condition and stage of development, announced that it would "peak its carbon dioxide emissions by around 2030, cut its greenhouse gas emissions per unit of GDP by 60%-65% from 2005 level, increase the share of non-fossil energy as part of its primary energy consumption to about 20% by 2030, and increase its forest stock volume by around 4.5 billion cubic meters from the 2005 level," further showing its determination to shoulder international responsibility as a major country, and setting carbon emission restrictions on its future economic development.

1.2 Challenges facing China's economic growth when it fulfils its carbon emission reduction promise

The carbon emission reduction target China willingly and determinedly announced at the Paris Agreement is very challenging.

First, China's cost per unit of carbon dioxide emissions will increase continuously and remarkably. If China sets carbon emission restrictions so that "its carbon dioxide emissions per unit of GDP will decrease by 63% by 2030 from 2005 level ," and evenly distributes the pressure on emission reduction in each year, then by 2020, 2025 and 2030, its cost per unit of carbon dioxide emissions will reach US$ 38.81, US$ 65.60 and US$ 97.90, respectively.① In terms of intended nationally determined contributions mentioned in the Paris Agreement, India pledged "33%-35% cut in carbon dioxide emissions per unit of GDP by 2030 from 2005 level." If India also fulfils its emission reduction promise, then by 2020, 2025 and 2030, its cost per unit of carbon dioxide emissions will be US $6.78, US$ 11.00 and US $15.94, respectively. It can be seen from the comparison that though China and India are the world's two most populous countries, it is much more difficult and costly for China to fulfil its emission reduction promise.

Second, China's economic losses caused by carbon emission reductions will be higher than those of other countries. If we, with 2012 as the base, calculate the cumulative GDP losses of the world's major countries by 2025 when they fulfil their respective emission reduction promises, we can get the following results: China will lose 6.51% of its GDP, the US will lose 2.10%, Japan, 4.29%, the EU, 2.32%, Canada, 2.21%, Brazil, 1.96%,

① Calculated based on constant 2012 US$. The same below.

India, 2.10%, and Russia, 1.00% (Qiao, 2016). China's carbon emission reduction target means China will suffer the greatest economic losses to promote emission reduction. A loss of 6.51% of the GDP under the new normal of China's economy roughly equals the increase in its GDP in a year.

Third, the carbon emission peak China set establishes the ceiling of China's future emissions, and limits its per capita historical cumulative emissions to low levels. China proposed that it would peak its carbon dioxide emissions by around 2030. This means that in a longer period, the upper limit of China's total carbon emissions will be fixed. As we know, the two industrial revolutions greatly promoted the development of social productivity, and history repeatedly proved that industrialization is the only way to modernization. Both steam power that emerged in the first industrial revolution and electric power and the petroleum industry that rapidly developed in the second industrial revolution are closely related to carbon emissions caused by consumption of fossil energy. The gap between developed countries and developing countries in today's world was largely created by the earlier or later initiation of industrialization in these countries. Those countries that were industrialized earlier extensively consumed fossil energy and cumulated more carbon emissions in history, enabling them to become today's developed countries. The delayed industrialization of developing countries, on the contrary, hindered their technological advancement and economic development, and resulted in that their historical cumulative carbon emissions to be relatively low. When the populations of different countries are considered, normally per capita historical cumulative emissions can be used to measure a country's contributions when it responds to global climatic change. According to calculations, based on the populations of the major economies in 2012, the per capita historical cumulative emissions of China, the US, the EU and Japan were 111.13, 1,166.53, 651.46 and 399.84 tons of carbon dioxide/person, respectively. Supposing all countries can fulfil the intended nationally determined contributions they submitted, and, calculated based on their current populations, the per capita historical cumulative emissions of the above mentioned countries will reach 332.91, 1,356.62, 772.79 and 560.69 tons of carbon dioxide/person, respectively, in 2030 (Qiao & He, 2016). When the 2030 levels and the 2012 levels are compared, it is not difficult to see that China's per capita historical cumulative emissions, though becoming proportionally closer to those of developed countries, will still fall far behind in the absolute sense. As it is unlikely that China's population will decrease sharply in the near future, its per capita historical cumulative emissions will remain much lower than those of developed countries over the long term.

2. The core issue concerning the green and low carbon development of the Chinese economy and the main way to promote it

2.1 The core issue concerning the green and low carbon development of the Chinese economy is to optimize carbon allocation through carbon restrictions

When a country ratifies the Paris Agreement, and sets its carbon emission reduction target in intended nationally determined contributions, it also means that this country puts carbon emission restrictions in its economic development. Fossil energy sources are still dominant in the global energy mix, restricted carbon emissions will become scarce resources, and the proper allocation of limited carbon emissions to achieve better economic growth will become the core issue concerning green and low carbon development.

A theoretically feasible way to meet these emission restrictions is to consume energy sources having equivalent heat energy yet meeting carbon emission restrictions. This requires adjustment of the proportions of different kinds of energy sources consumed, i.e., reducing the consumption of high carbon coal and petroleum and increasing the consumption of low carbon natural gas or clean energy. However, when adjusting the proportions of different kinds of energy sources consumed, both carbon emissions and their costs, namely the economy, must be taken into account. Due to the current technology and the relative prices of different kinds of energy sources, low carbon or clean energy sources are obviously most costly. And, once the Paris Agreement is enforced, if all the countries shift to consuming low carbon and clean energy, then the gap between the relative prices of different kinds of energy sources will certainly be further widened due to the change in the demand structure. This will make the shift to consuming low carbon energy sources even more expensive causing some economic contraction. Therefore, it is more important to reallocate total energy consumption under carbon emission restrictions. The reallocation can be optimized at least on the supply and demand sides. Taking the consumption of electric power for example, power rates, on the one hand, influence the supply side as part of the costs of manufacturers, and, on the other hand, are a necessary living expense of the residents. Allocating more of the limited energy consumption to the supply side helps reduce product costs, but may inhibit final consumer demand. Otherwise, product costs will increase and consumer demand will grow. Of course, with the furthering of economic globalization, countries will become increasingly interrelated and therefore the above mentioned influence must be considered along with international trade, so as to comprehensively assess and determine an energy allocation structure best able to improve the well-being of the citizens or promote a country's economic growth. If we closely examine the production side, we will also find that energy consumption per unit output value varies with different industries, and carbon emissions directly generated from production also differ. This will further influence the industrial restructuring on the supply side. Of course, these analyses assume the technology will remain unchanged. If a significant breakthrough is made in low carbon technology or energy saving technology, the above considerations should be improved.

2.2 Deepening structural adjustment as the main way to promote the green and low carbon development of the Chinese economy

Let C denote total carbon emission, E denote total energy consumption, Y denote total GDP, and P denote total population, then, according to the Kaya equation, we get the following logical relation: $C=(C/E)\times(E/Y)\times(Y/P)\times P$. This equation shows that a country's total carbon emissions are primarily influenced by four factors: 1) P, namely, the change in total population; obviously, the more the population, the more energy sources and energy products will be consumed, and therefore more carbon emissions. 2) Y/P, namely, per capita GDP; this shows that with a given energy structure, industrial structure and relevant technology, the higher the per capita GDP (indicating per capita economic growth), the higher total carbon emissions will be. 3) E/Y, namely, energy consumption per unit of GDP; this indicator is obviously influenced by the technology, but more importantly, it is related to the industrial structure. If high-energy consuming industries account for a very high share in the economic aggregate, then energy consumption per unit of GDP will be greater. And 4) C/E, namely, carbon emissions per unit of energy; this indicator is primarily influenced by energy

structures. If high carbon energy sources account for a very high share in total energy consumption, this indicator will certainly be rather high.

Based on the above framework, we can analyze the characteristics of China's carbon emissions and their determinants. Our idea is to first conduct a historical comparison to find the main reason why China's total carbon emissions increased, and then conduct an international comparison to find the gap and the key to promoting green and low carbon economic development.

From 1990 to 2012, China's population increased by 18.46% from 1,143 million to 1,354 million, and its total GDP increased by 27.41 times from RMB 1,880 billion to RMB 53,410 billion; its total energy consumption increased by 2.58 times from 953.84 million tons of standard coal to 3,410.94 million tons of standard coal; its total carbon emissions increased by 2.96 times from 2,349.50 million tons to 9,312.53 million tons.① Based on the above data, we can further calculate Y/P, E/Y and C/E. In 1990 and 2012, Y/P was RMB 1,645 and RMB 39,446, respectively; E/Y was 5.07 tons of standard coal/RMB 10,000 and 0.64 tons of standard coal/RMB 10,000, respectively; and C/E was 2.46 tons of carbon dioxide/ton of standard coal and 2.73 tons of carbon dioxide/ton of standard coal, respectively. From the above data China's total carbon emissions continuously increased primarily because of population increase and economic growth, particularly the growth of per capita GDP. In addition, China's energy consumption per unit of GDP decreased over this term, indicating positive progress in energy conservation and emission reductions through the adjustments of industrial structures and in advancements in technology significantly inhibited the increase in total carbon emissions. Carbon emissions per unit of energy slightly increased, indicating that though China's energy structure has improved in recent years, coal and other high carbon energy sources are still dominant (Qiao, 2015).

Next, we can conduct an international comparison. First, let us look at energy consumption per unit of GDP. In 2011, China's electricity consumption per unit of GDP was 1.06 KWh/US$, and the world average was 0.39 KWh/US$.② Compared with the world average, China's energy utilization rate is still rather low. This is primarily related to China's industrial structure. With the furthering of China's industrialization when China plays the role as the "world's factory," some high energy consuming industries account for a rather high share in China's industrial structure, making its energy consumption per unit of GDP increase. Second, let us look at energy structure and energy saving technologies. Taking thermal power for example, in 2010, coal accounted for 94.3% of China's thermal power sources, petroleum accounted for 0.5% thereof, and natural gas, 2.3%; however, coal accounted for 42.6% of Japan's thermal power sources, petroleum, 14.0%, and natural gas, 43.4%. In 2010, China thermal power plants consumed 312 g of standard coal/KWh, while Japan consumed 294 g of standard coal/KWh. This indicates that in terms of both energy structure and energy saving technology, China still falls far behind Japan and other developed countries.

From the above comparisons, we can draw the following conclusions: 1) To achieve its Two Centenary Goals, even if the Chinese economy enters a new normal, China still needs to maintain a medium-to-high growth rate. This means that

① See CAIT–WRI's Climate Data Explorer.
② US$ here is constant 2005 US$.

In 2010, China thermal power plants consumed 312 g of standard coal/KWh.

it is impossible for China to cut carbon emissions by excessively lowering its economic growth rate. 2) As China's carbon emissions per unit of energy are high, China has great potential to cut its total carbon emissions in the future by adjusting its energy structure. And 3) though China's energy consumption per unit of GDP decreased remarkably in the past two decades, China, as seen from the international comparison, still has great potential to cut its total carbon emissions by continuously optimizing its industrial structure.

3. Strategies to promote the green and low carbon development of the Chinese economy

3.1 Establishing a clean, low carbon modern energy system

To fulfil its promise for intended nationally determined contributions in the Paris Agreement and promote the green and low carbon development of its economy, China should first adjust its energy structure to meet carbon emission restrictions while maintaining economic growth and even increasing its total energy consumption. In 2012, China's structure of primary energy consumption was as follows: coal accounted for 66.03%, petroleum, 17.51%, natural gas, 5.62%, nuclear energy, 0.96%, hydroelectricity, 8.10%, and renewable energy sources, 1.79%; however, the world's then energy structure was as follows: coal accounted for 30.03%, petroleum, 32.57%, natural gas, 23.71%, nuclear energy, 4.44%, hydroelectricity, 6.80%, and renewable energy sources, 2.45%.[①] By comparing the above data, we can see that: 1) In terms of fossil energy consumption, China's coal consumption accounted for a greater share than the world average, but its petroleum consumption and natural gas consumption accounted for lower shares than world average. Therefore, cutting coal consumption will be key to promoting China's carbon emission reductions, and to replace coal consumption, China should continuously increase the consumption of lower carbon, cleaner natural gas. After the

① See the *BP Statistical Review of World Energy*.

global financial crisis, one noteworthy trend is the emergence of the "shale gas revolution," which helped the US become a major natural gas producer like Russia and have the ability to change the world's natural gas supply structure. Therefore, considering China's shale gas reserves, we should pay close attention to and track the advancement of shale gas exploration technology. And 2) in terms of non-fossil energy consumption, China's nuclear energy consumption and renewable energy sources consumption accounted for lower shares than world averages, but its hydroelectricity consumption accounted for a slightly higher share than the world average. This shows that China has great potential to consume more nuclear energy as well as wind energy, solar energy and other renewable energy sources, while these energy sources are clean in terms of carbon emissions, helping to meet the carbon emission reduction target. To respond to global climate change and ensure national energy security, nuclear energy should play a more important role in China's overall energy strategy. As calculated, when its carbon emission reduction promise is fulfilled, China's energy consumption structure in 2030 best promoting economic growth is that coal accounts for 59.49%, petroleum, 17.38%, natural gas, 6.00%, and non-fossil energy, 17.14%. This result is close to what China proposed: "The share of non-fossil energy in primary energy consumption reaches around 20%."

3.2 Establishing a green and low carbon modern industrial system

Besides the establishment of a green, clean modern energy system, establishing a green and

China has great potential to consume more nuclear energy as well as wind energy, solar energy and other renewable energy sources.

low carbon modern industrial system also plays an important part in promoting carbon emission reductions. With the environmental problems, China's environmental carrying capacity has reached or is approaching its upper limit, and its future environmental costs will continuously increase. Among the costs, carbon emission costs, under the influence of the Paris Agreement, will increase markedly. As the carbon emissions of different industries vary greatly, the increase in emission costs will cause gradual industrial restructuring. As calculated, when China fulfils its carbon emission reduction promise, with 2012 as the base, by 2030, China's agriculture, mining, high-end manufacturing, other industrial sectors and the service industry will achieve accumulated growth rates of 257.67%, 233.02%, 266.05%, 306.38% and 309.40%, respectively. Thus, the service industry including the high-end service industry (including mechanical equipment, electrical and optical equipment, transportation equipment, chemicals and related products) will grow most markedly, and the mining industry will be most seriously affected. Meanwhile, other industrial sectors will also be markedly affected.

In addition to the above estimation, this paper has three more points to make: 1) Though the service industry will be least affected, the key to China's industrial upgrading in the future is still the industrialization of capital goods. Choosing such a strategy does not mean discouraging or even restricting the development of the service industry; instead, the development of the service industry, especially productive services, will be encouraged, and it is allowed that the service industry accounts for a greater share. However, when it comes to industrial upgrading, gradually narrowing the gap in high-end manufacturing between China and Germany, Japan and other countries, and promoting the development of China's capital goods industry will still be an important, necessary part of China's continuing development. 2) The green development of the Chinese economy is possible only by improving technology, extending the production chain, and promoting the development of highly industrialized production. Otherwise, China will be caught in the "environmental cost paradox," which means that in the initial stage of industrialization, by receiving international industrial transfer, a developing country can learn technology, accumulate capital, and then achieve accumulation of part of the capital goods in the entire roundabout production chain, and achieve economic growth by product competitiveness created by low environmental costs. However, later, if no breakthrough is made in high technology production, the country will be caught in a dilemma. On the one hand, increasing environmental costs will cause the loss of product competitiveness, and then affect economic growth and employment. On the other hand, if pollutant emissions are still not controlled, the country's environment will continue to deteriorate and become unbearable. The key to this paradox is to industrialize capital goods and break down the technical barriers to high-end commercial manufacturing. This means that the key to the green development of a country's economy is to find new competitiveness. And 3) in breaking down the technical barriers, the government must play an important role primarily by properly conducting environmental supervision and strictly imposing environmental restrictions, so that polluting enterprises have to internalize their environmental costs, and by properly adjusting the profit structure involving different industrial sectors and encouraging resources to flow to technological innovation and the real economy under the market mechanism, so as to avoid economic bubbles and economic virtualization.

3.3 Being actively involved in international

cooperation on carbon emission reduction

Under the framework of the Kyoto Protocol, Emission Trading (ET), Clean Development Mechanism (CDM) and other institutional arrangements for international cooperation on carbon emission reduction were proposed. In the practice that followed, not only much progress was made and rich experience was gained in these mechanisms. Many countries and regions also established local carbon emission trading systems. Among them, China is the world's biggest seller in the CDM market. Meanwhile, China has carried out carbon emission trading experiments in seven regions, and will establish a nationwide carbon emission trading system in 2017. Recently, the Joint Crediting Mechanism (JCM) and the Sectoral Crediting Mechanism (SCM) and other new trading mechanisms have been proposed, representing further innovations in mechanisms for international cooperation on carbon emission reductions. This time, Article 6 of the Paris Agreement also reaffirms the importance of voluntary trading. As calculated, if China is involved in global carbon emission trading, as China's carbon emission costs are lower than those of the US, the EU, Japan and other developed countries, China will become the largest carbon emission quota seller, and its market share will account for 40%-55% of the total global trading volume, thereby helping the international quota price to decrease by 14%. This means that China will play an important role in future global carbon emission trading, and have a great say in pricing. To be specific, if all the countries in the world independently promote carbon emission reduction, then from 2012 to 2025, China's total GDP, residents' consumption, investment, government consumption, and exports and imports will increase or decrease by -6.51%, -13.69%, -16.47%, 55.53%, -18.77% and -17.29%, respectively. If all the countries in the world are involved in carbon emission trading, these items in China will increase or decrease by -6.39%, -14.52%, -13.34%, 64.00%, -25.05% and -15.61%, respectively. Comparing these results in two situations, we can see that China, as a carbon emission quota seller involved in global carbon emission trading, must reduce energy consumption and carbon emissions so that its domestic carbon emission costs will further increase, thereby inhibiting exports, reducing imports and promoting investment and government consumption, and of course, gaining income from selling the quota, therefore lowering the overall economic decline. Therefore, being actively involved in international cooperation on carbon emission reductions not only helps improve a country's economy, but more importantly, helps a country gain influence in the carbon emission trading market. In addition, China's carbon emission reductions not only help slow climate change, but also has an extremely important spillover effect on the control of other types of environmental pollution. For example, reducing coal consumption can reduce not only carbon emissions but also sulphur dioxide and suspended particle emissions. Should China meet its target in intended nationally determined contributions, its haze pollution will decrease by 42%. [①] If the spillover effect of these carbon emission reductions are also taken into account, the potential benefits of being involved in international cooperation on carbon emission reductions will possibly be even higher.

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REFERENCES

Qiao Xiaonan. (2016). An assessment of the influence of the Paris Agreement on the world economy. *A Working Paper*, (7). This paper was also referred to when conducting estimation and calculations with regard to the adjustment of energy structure and industrial structure later.

Qiao Xiaonan. (2015). Design of the emission trading system and innovation in carbon finance in the context of China's industrial restructuring. *Planned Philosophical and Social Science Projects of Tianjin: Study Reports*, (8).

Qiao Xiaonan & He Zili. (2016). Understanding the Paris Agreement—a framework to analyze industrial transformation and carbon emissions. *Review of Political Economy*, (3).

Stern N. (2007). *The economics of climate change: The Stern review*. Cambridge University Press.