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Industrial Low-Carbon: Dilemma and Path Selection (Case Study of Jiangxi Province)

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Since the Industrial Revolution, the mode of economic development characterized in high energy consumption, high pollution and high emission based on fossil fuels has not only driven the rapid development of economy and society, but also leads to a series of ecological and environmental problems such as global warming, energy shortage, and environmental degradation, resulting in sharp contradictions between ecological environment and economic development, which have been the bottleneck and constraints increasingly restricting the economic and social development. Under such circumstances, the low-carbon economy has emerged and been gradually accepted by the world, forming the industrial low-carbon, which has been a major trend for the world economy.

I. Development of China's carbon emission and industrial low-carbon

According to the data from climate analysis tool of the World Resources Institute (WRI) 2009, China, the United States, European Union, Russia and India and the remaining five nations are the top ten countries with carbon emissions. See *table 1*.

From table 1, although China's carbon emission has ranked the first in the world, its per capita carbon emission has ranked 72nd; American carbon emission has ranked the second in the world, but the per capita carbon emission has ranked 7th; and Russia's carbon emission has ranked 4th, but the per capita carbon emission has ranked 18th.

To address the climate change, in the General Climate Assembly in Copenhagen

Table 1. Top ten nations with carbon emissions

Rank	Nation	Emission load (a)	Percentage of the world	Quantity per capita (b)
1	China	7219.2	19.12%	5.5 tons (72)
2	U.S.	6963.8	18.44%	23.5 (7)
3	EU	5047.7	13.37%	10.3 (39)
4	Russia	1960.0	5.19%	13.7 (18)
5	India	1852.9	4.91%	1.7 (120)
6	Japan	1342.7	3.56%	10.5 (37)
7	Brazil	1014.1	2.69%	5.4 (74)
8	Germany	977.4	2.59%	11.9 (25)
9	Canada	731.6	1.94%	22.6 (8)
10	British	639.8	1.69%	10.6 (36)

Notes:
(a) In one million tons, including the emission loads of six kinds of greenhouse gases, expressed by carbon dioxide equivalent (CO_{2e}).
(b) Ranked by the amount per capita.
Source: Climate analysis tool of World Resources Institute (WRI) 2009, data of 2005.

convened in December 2009, China's government with highly-developed sense of responsibility, gave the solemn promise to the world: the carbon emissions per GDP in 2020 would be 40-45% lower than those in 2005, and the proportion of the non-fossil fuels consumed would be around 15% to the primary energy consumed. To achieve this goal, Chinese government has set up the climate change leading group, National Energy Bureau, China Energy Conservation Center and other specialized agencies to address climate change, to safeguard the energy security and to promote the development of industrial low-carbon. Furthermore, Chinese government has formulated a series of policies and measures on low-carbon development, including *Circular Economy Promotion Law of the People's Republic of China*, *Renewable Energy Law of the People's Republic of China* (amendment), *Outline of China's Policies concerning the Comprehensive Utilization Technology of Resources*, *Opinions on Accelerating the Development of Energy Conservation and Environment Protection Industries* and others, specifying the path to the development of industrial low-carbon: vigorously developing the strategic and emerging industries characterized in low energy and resource consumption, good economic returns, and broad market prospects, promoting the transformation of traditional industries to low-carbon, and increasing the proportion of modern service industry in the economy. Furthermore, Chinese government has implemented the specific enterprise-oriented projects specifically for the low-carbon industries, such as Top 1000 Energy-Consuming Enterprises Program, Top 10000 Enterprises Energy Efficiency Program and Eliminating Backward Production Capacity Program; moreover, Chinese government has launched

the specific engineering for the low-carbon industries such as Energy-saving Products Benefiting People Program, Golden-sun Demonstration Project and others.

II. Practice and dilemma of industrial low-carbon in Jiangxi

In recent years, Jiangxi government has carried out useful explorations and practices on industrial low-carbon: a) promoting the technological innovation of energy-intensive industries, expanding and modernizing main equipment in high energy-consuming industries such as cement, steel and thermal power, promoting the energy conservation and emission reduction technology and reducing the energy consumption in these industries, for example, installing the residual heat and pressure utilization devices to major steel companies such as power generation device of differential pressure for blast furnace, power generation device of coke dry quenching and others, providing low-temperature residual heat power generation device to cement clinker production line of new rotary kilns and installing desulphurization equipment in the thermal power industry; b) eliminating the backward production capacity, decommissioning a number of production lines characterized in high energy consumption and high pollution in thermal power, steel, cement and other industries; c) implementing a number of key projects on energy efficiency in buildings, transportation and other areas, for example, the promotion of green building materials, the implementation of contract energy management, the implementation of Golden Sun works and the promotion of new energy vehicles in the public transport sector and others; d) striving to develop ten strategic and emerging industries such as new energy, new materials, biology and new medicine, new generation of information technology, aviation industries, advanced equipment manufacturing, lithium and electric cars and to develop eco-tourism, e-commerce, software and service outsourcing and other modern services.

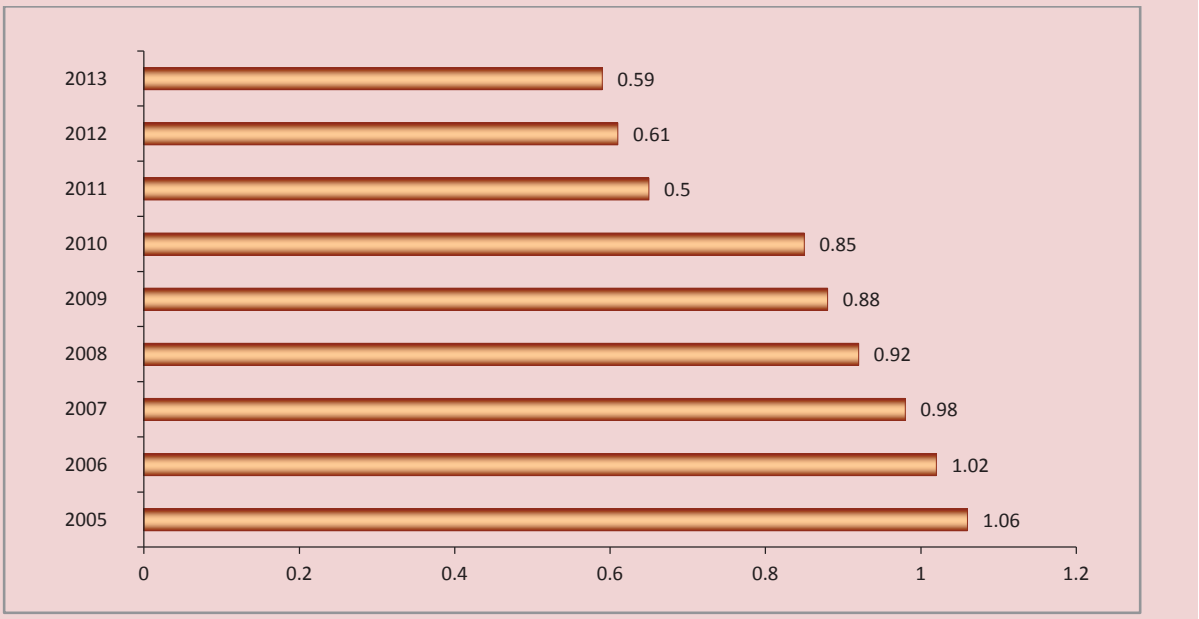
Through above actions and measures, the industrial low-carbon strategy in Jiangxi has achieved remarkable results: the proportion of new strategic industries and high-tech industries is increased in overall economy and the overall energy consumption per unit of GDP has continued to decrease. In 2013, overall energy consumption of GDP of RMB 10,000 Yuan was 0.59 tons of standard coal, decreased by 30.6% compared with that in 2010 *(figure 1)*. And the emission level of output value of RMB 10,000 Yuan has also been decreased.

However, the industrial low-carbon in Jiangxi has achieved positive progresses, but also faced with a number of difficulties.

1. Constraints of the mid-industrialization

Being in the early stage of the mid-industrialization, Jiangxi has not completed the task of industrialization; and for a long period of time in the future, Jiangxi's government will have to adhere to the industrialization-led development strategy, accelerate the industrialization, speed up the transfer of industries both at home and

Figure 1. Energy intensity of Jiangxi
(unit: ton of standard coal / GDP of RMB 10,000 Yuan)



abroad. As we all know, the advance of industrialization requires a lot of energy for support, proved by the fact that the advance of industrialization in Jiangxi has been accompanied with a substantial increase in energy consumption since the new century *(figure 2)*. Therefore, theoretically speaking, the carbon emission load in Jiangxi Province will continue in inverted-U upward trend in the coming period, indicating that Jiangxi government has still a long way from the development of industrial low-carbon.

2. Constraints of the energy consumption structure

The coal-dominated energy structure has seriously affected the carbon emissions of Jiangxi. *Table 2* shows the information on carbon dioxide emissions of primary energies. From the table, the carbon dioxide emission is the highest whether the primary energies are used for power generation or for heating.

The proportion of coal consumption of Jiangxi to total energy consumption is maintained at 67.8% ~ 74.5% since the new century *(see figure 3)*.

Based on the characteristics of energy resources in China of being rich in coal resources and inadequate in oil and gas resources, the coal-dominated energy consumption structure characterized by high carbon emission will be difficult to be changed in Jiangxi in the future for a long period of time, which will be a constraint for the transformation of Jiangxi to low-carbon industry in a long term.

Figure 2. Change of total energy consumption in Jiangxi Province in 2000–2012
(unit: 10,000 tons of standard coal)

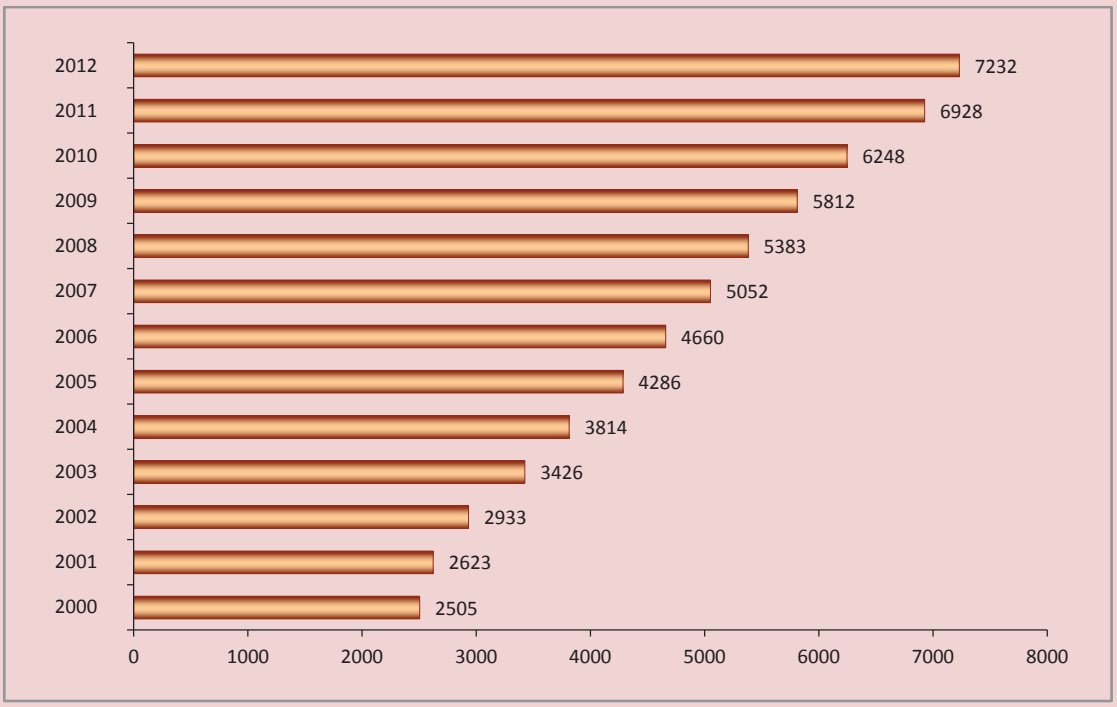


Table 2. Comparison of carbon emissions of different energies for power generation unit: g / kWh

Energy type	CO_2 emission load
Biomass gas	409
Wind power for electricity generation	24
solar power for electricity generation	27
Nuclear power for electricity generation	32
Natural gas (heating)	49
Solar power cell	101
Natural gas (steam for electricity generation + heating)	148
Natural gas (steam for electricity generation)	428
Stone Coal (heating)	622
Lignite (heating)	729
Stone coal (for electricity generation)	949
Lignite power for electricity generation	1153
Source: German Oeko-institut FR-infografik, information from World's Wind Power Network.	

Figure 3. Proportion of coal consumption of Jiangxi to total energy consumption (%)

Table 3. Energy consumption and carbon emission of three industries of Jiangxi

Three Industries	Primary industry	Secondary industry	Tertiary industry
Average energy intensity (tons /10,000Yuan)	0.11	0.85	0.43
Carbon emissions	Low	High	Medium

3. Constraints of the industrial structure

From the carbon emission loads of three industries, the carbon emission of the secondary industry is much higher than that of the tertiary industry and the primary industry *(see table 3)*.

Due to the rapid progress of industrialization in Jiangxi Province, the industry has been dominated in the national economy, ranked in Secondary Industry, Tertiary Industry, and Primary Industry.

Also, in the secondary industry, the heavy chemical industry characterized in large energy intensity has occupied a particularly large proportion, which makes the industrial low-carbon development in Jiangxi extremely hard.

4. Slow development of low-carbon technology

Low-carbon technology has been the important support to the development of industrial low-carbon. As a less developed region, Jiangxi possesses underdeveloped overall technologies and limited R&D capabilities; furthermore, the clean and efficient use of renewable energy, new energy, and coal, carbon dioxide capture and storage and other low-carbon

technology research and development is at a starting stage.

5. Imperfect relevant laws and rules and market system

Although in recent years, the Chinese government and local government in Jiangxi has issued a series of legal documents directly related to low-carbon development, generally speaking, the policies and legal systems for the promotion of low-carbon economic development have been still in a weak state, and the production activities of governments at all levels, enterprises and individuals have not been strictly limited and the market-based incentive and restrictive mechanism has been unavailable. Jiangxi government has not established the carbon emission trading market of provincial level, and the energy conservation and emission reduction standards on a variety of industries and products are incomplete.

III. Path Selection for industrial low-carbon of Jiangxi

1. Increasing the proportion of tertiary industry in economic aggregate

From the structure of three industries, the emission level of the tertiary industry has been significantly lower than that of the second industry; based on such realities, when conducting the path selection of industrial low-carbon development, Jiangxi government must vigorously develop the tertiary industry, gradually increase the proportion of tertiary industry, namely service industry in economic aggregate, and adjust the proportion of three industries as well as promote the transformation of industrial low-carbon.

2. Achieving the low-carbon development within three industries

Vigorously developing the low-carbon agriculture: first, significantly reducing the amount of fertilizers and pesticides used, lowering the dependency of agricultural production process on fossil fuels, and taking the road of organic ecological agriculture; second, making full use of the remaining energy from agriculture. Furthermore, it needs to actively explore the new ways for the utilization of crop straw resources, promote solar energy and biogas technologies and make use of livestock manure from large-scale livestock farming for developing biogas, so as to obtain biomass.

Energetically developing the low-carbon industry: focusing on adjusting the internal industrial structure within the industry, raising the threshold of market access of some energy-intensive industries, eliminating the backward production capacities, giving priority to the development of energy-saving and environmental protection industry, new energy and new material, biology and new medicine, new generation of information technology, aviation industries, advanced equipment manufacturing, lithium and electric vehicles and other strategic and emerging industries; while realizing the expansion of gross scale, continuing to reduce the energy consumption per unit of industrial added value, and controlling the growth of total industrial energy consumption; with the promotion of advanced and practical technologies, R&D of extended technologies, achieving

the comprehensive modification and improvement of traditional industries, extending the industrial chain, increasing the efficiency of energy use of industries, and lowering the polluting emission level of traditional iron and steel, nonferrous metals, building materials, chemicals and other industries characterized in high energy consumption and high pollution.

Energetically developing the low-carbon service industry: focusing on the construction of tourist attractions, green hotels, low-carbon tourist cities and green enterprises, promoting the transformation of tourism development, actively integrating with low-carbon industry development strategies of Jiangxi; expanding the cultural industries for press and publications, cultural performances, animation games, advertisement and exhibitions; and accelerating the transformation of low-carbon of the transportation industry, substantially saving energy, carbon dioxide emission and water.

3. Upgrading the technological innovation of the low-carbon industry

Starting from the development of core technologies for industrial low-carbon, it needs to highlight the dominant position of enterprises in technological innovation, scientifically give play to the macro-control functions of governments, and adjust the behaviors of relevant subjects through institutional innovation, so as to protect the effective flow of low-carbon industrial technologies and knowledge during the dynamic innovation, and to promote the low-carbon innovation process of all dimensions and all value chains. Through original innovation and integrated innovation, it needs to focus on the low-carbon technologies that allow larger benefits in short and medium periods of time, and independently develop the unique low-carbon industrial technology innovation system.

4. Building the low-carbon energy structure system

By increasing the level of energy technology and widely promoting clean coal and other advanced energy technologies, it can reduce the emissions of pollutants, vigorously develop clean energy sources, including renewable energy, gradually change the energy situation of over-reliance on coal, promote the diversification of energy supply, and gradually increase the proportion of new energy and renewable energy in the energy mix. In addition, it needs to orderly develop the hydropower, accelerate the development of wind energy and solar energy; furthermore, it needs to reasonably and orderly develop the nuclear energy, and promote the development of biomass energy without security loss.

5. Adhering to the industrial transfer at home and abroad with the precondition of low-carbon development

It is necessary to focus on the market access, strictly limit the transfer of high-carbon industries, well restrict the incremental low carbon from the industrial transfer at home and abroad; to focus on the guidance and control of the production

process, strengthen the institutional innovation, promote the low-carbon transformation of stocks of domestic and foreign-funded companies in the high-carbon industry in Jiangxi and pay close attention to the transfer of international low-carbon technologies, and promote the industrial low-carbon innovation and the development of new and strategic industries of Jiangxi.

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