Exploring the peak path of carbon emissions in the Yangtze River Delta

LinLin Cai¹, XinTong Ge²
¹Tianjin University of Science and Technology, Tianjin, 300222, China
²Tianjin University of Science and Technology, Tianjin, 300222, China
*corresponding author’s e-mail: 18322598379@163.com

Abstract. According to the government's main functional area planning, this paper summarizes the data of 15 optimized development regional cities in the Yangtze River Delta, including GDP, population, energy consumption, etc., refer to government planning, set the growth rate of each indicator under three scenarios, and predict the Yangtze River Delta carbon. Emission peak year and energy structure, industrial structure, and give advice.

1. Introduction

According to the division of the country's main functional areas, the Jiangsu Provincial Government issued the “Jiangsu Province Main Functional Area Plan” in February 2014, clarifying that Jiangsu Province's optimized development area refers to the northern core area of the Yangtze River Delta, including Nanjing, Wuxi, Changzhou, Suzhou and Zhenjiang. Most of the districts and the urban areas of Nantong, Yangzhou and Taizhou; the Zhejiang Provincial Government issued the “Zhejiang Main Functional Area Plan” in October 2013, clarifying that the optimized development areas of Zhejiang Province mainly include the Hangzhou Bay Area, namely Hangzhou, Huzhou and Shaoxing. Ningbo, Zhoushan, Jiaxing and other regions.

In 2016, the “13th Five-Year Plan for Controlling Greenhouse Gas Emissions” issued by the State Council clearly pointed out that the carbon emissions in support of optimized development regions will reach the peak first, and some heavy chemical industries will achieve carbon emission peaks around 2020. The low-carbon transformation of the energy system, industrial system and consumption sector has achieved positive results. In addition to Shanghai, there are 15 optimized development regional cities in the Yangtze River Delta. In order to achieve the goal of reaching the peak, the data of these cities will be summarized, and different growth rates will be set according to different scenarios and indicators. The peak years of 15 cities in the Yangtze River Delta will be predicted, and the energy structure and industrial structure will be analyzed. Provide reference for the Yangtze River Delta optimization development area to achieve carbon emission peaks as soon as possible, and demonstrate for other regions.

2. Three scenarios and carbon emissions in different scenarios

First, set the following three scenarios,(1) Baseline scenario: ensuring rapid economic and population growth; coal is slowing down; oil, natural gas, and purchased electricity are growing at current growth rates.(2) Policy scenarios: economic and population growth according to government planning; reduction of total coal volume according to planning requirements; control of oil consumption growth, vigorous development of natural gas, efforts to increase the proportion of natural gas; increase the
proportion of purchased electricity; increase the installed capacity of new energy capacity.(3) Strengthening the low-carbon scenario: The Intergovernmental Panel on Climate Change (IPCC) issued a report, “IPCC Global Warming 1.5°C Special Report”, which states that it is limited to 1.5°C compared to limiting global warming to 2°C. Human and natural ecosystems have obvious benefits. To achieve the 1.5°C temperature control target, global climate action needs to be accelerated to achieve carbon dioxide emission reduction and substantial emission reduction. The Yangtze River Delta achieved near-zero emissions supported by new energy and renewable energy in 2050. The economy and the population are growing at a low rate; further reducing the proportion of coal and oil; accelerating the pace of development of natural gas; further increasing the proportion of purchased electricity and the installed capacity of local new energy. After 2030, it mainly relies on clean energy.

Table 1. Growth rate of each indicator

|                | 2020-2025 | 2026-2030 | 2030-2040 | 2040-2050 |
|----------------|-----------|-----------|-----------|-----------|
| **Baseline**   | 0.09      | 0.07      | 0.07      | 0.07      |
| **Policy**     | 0.08      | 0.07      | 0.07      | 0.07      |
| **Strengthened** | 0.08 | 0.07 | 0.07 | 0.07 |
| **Baseline**   | 0.02      | 0.02      | 0.02      | 0.02      |
| **Policy**     | 0.02      | 0.02      | 0.02      | 0.02      |
| **Strengthened** | 0.02 | 0.02 | 0.02 | 0.02 |
| **Baseline**   | 0.03      | 0.03      | 0.02      | 0.02      |
| **Policy**     | 0.03      | 0.03      | 0.02      | 0.02      |
| **Strengthened** | 0.02 | 0.02 | 0.02 | 0.02 |
| **Baseline**   | -0.06     | -0.07     | -0.07     | -0.07     |
| **Policy**     | -0.07     | -0.07     | -0.07     | -0.07     |
| **Strengthened** | -0.07 | -0.07 | -0.07 | -0.07 |
| **Baseline**   | 0.00      | -0.01     | -0.01     | -0.01     |
| **Policy**     | -0.01     | -0.01     | -0.01     | -0.01     |
| **Strengthened** | -0.01 | -0.01 | -0.01 | -0.01 |
| **Baseline**   | -0.07     | -0.08     | -0.08     | -0.07     |
| **Policy**     | -0.08     | -0.08     | -0.07     | -0.07     |
| **Strengthened** | -0.08 | -0.08 | -0.07 | -0.07 |

With the passage of time, the growth rate of GDP will slow down. At present, GDP growth rate is around 8%, and the economy is growing at a high speed. Under the baseline situation, GDP growth rate is the highest, at the expense of environmental pollution, and policy scenarios are second. Policy constraints, while reducing carbon emissions, control the growth rate of GDP. Under the low carbon situation, the GDP growth rate is the lowest, and the low economic growth rate provides more space for emission reduction. Considering the birth rate and the attraction of talents in the Yangtze River Delta economic belt, the population has been growing slowly, but the growth rate has declined. Energy consumption is basically growing at a slower rate until 2030. After 2030, there will be a small downward trend in energy consumption under policy conditions and enhanced low-carbon conditions, possibly using more energy-efficient appliances and building more efficient production. Park and so on. Under the baseline scenario, carbon emissions will increase by 2025, and will decline slowly after 2025. Carbon emissions have been declining under policy and low-carbon scenarios, and low-carbon scenarios have declined more rapidly. The energy consumption per unit of GDP and carbon emissions per unit of GDP reflect the relationship between GDP growth and energy consumption and carbon emissions. After carbon emissions, energy consumption and GDP are decoupled, GDP growth will no longer be related to energy consumption and carbon emissions, or weakly related.

Table 2. 2020-2050 different indicator data

|                | 2020      | 2030      | 2040      | 2050      |
|----------------|-----------|-----------|-----------|-----------|
| **Baseline**   | 139376    | 136788    | 133543    | 313224    |
| **Policy**     | 133543    | 136788    | 139376    | 313224    |
| **Strengthened** | 136788 | 139376 | 133543 | 313224 |
| **Baseline**   | 58161     | 56128     | 54463     | 63417     |
| **Policy**     | 56128     | 58161     | 56134     | 48303     |
| **Strengthened** | 54463 | 56128 | 58161 | 48303 |
| **Baseline**   | 122275    | 115928    | 108605    | 125582    |
| **Policy**     | 115928    | 122275    | 110785    | 85206     |
| **Strengthened** | 108605 | 115928 | 122275 | 85206 |

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The above table shows the data of each indicator in different situations in the next 30 years. According to the growth rate of each indicator set in Table 1, the GDP, population, energy consumption and carbon emission data of different years can be calculated. In 2020, under the policy situation, the total GDP can reach 13,678.75 billion yuan, with a per capita GDP of 129,600 yuan, a per capita energy consumption of 5.32 tons of standard coal, and a per capita carbon emission of 10.98 tons. However, regardless of the situation, per capita GDP will show an upward trend in the next 30 years, per capita energy consumption will continue to decline, and per capita carbon emissions will decline. Considering the temperature rise of 1.5 degrees, the carbon emissions will drop sharply in the low carbon situation of 2030-2050, when most of the energy is non-fossil energy.

Figure 1. Carbon emission trends in three scenarios

The above chart shows the carbon emission trends in three scenarios. According to the forecast results, the Yangtze River Delta optimization development area peaks in 2020 under policy conditions, peaks in 2025 in the baseline case, and peaks in 2019 in the case of enhanced low carbon. In order to explain in detail the factors that contribute to carbon reduction, the energy is subdivided into coal, oil, natural gas and non-fossil energy, and the emission factor is kept constant, and the energy structure in different scenarios can be predicted. In the Yangtze River Delta Optimization Development Area, energy consumption in 2017 accounted for 39% of coal, oil accounted for 25%, and natural gas accounted for 5%. In the future energy structure adjustment, the government significantly increased the proportion of natural gas and non-fossil energy. Reduce the proportion of coal, so that the energy structure tends to be rationalized and clean. The energy structure under the policy scenario is shown in the following figure.

Figure 2. Energy structure under policy scenarios
Controlling greenhouse gas emissions is a long-term challenge. From the perspective of sustainability, since the Yangtze River Delta optimization development area includes 15 cities, the different development paths of 15 cities can combine many paths and move closer to the low-carbon scenario as soon as possible. If the global temperature rise issue is not paid enough attention and continue to develop according to the baseline scenario, the longer the carbon dioxide emissions will grow, the greater the cost of reducing emissions. If the total carbon emissions decline within 30 years, energy transformation must be realized as soon as possible. Under the policy scenario, natural gas, electric power, etc. will be used to replace coal. Coal will peak in 2019 and then will slowly decline. Due to insufficient natural gas supply, oil consumption will rise very slowly, reaching a peak in 2041, compared to 2017. About 8% increase, natural gas reached its peak in 2046. Compared with 2017, it increased by 60%. Under the low-carbon scenario, more clean energy is used to replace coal, oil and gas. Coal and oil peaked in 2018, showing a downward trend. Natural gas reached its peak in 2030. After 2030, non-fossil energy will become the dominant player in the energy arena. The cost of offshore wind power in Jiangsu and Zhejiang can be comparable to thermal power, stable output, further reduction in photovoltaic costs, and improved utilization, which can guarantee the supply of basic electricity, and nuclear energy is more widely used.

The emission reduction is not only the adjustment of the energy structure, but also the industrial structure. The following table shows the industrial structure under the policy situation. At present, the primary industry in the Yangtze River Delta accounts for 4%, and the secondary industry accounts for 50%. The tertiary industry with a proportion of 46%, with the upgrading and elimination of high-energy and high-pollution industries, the proportion of secondary production will gradually decrease, but the energy consumption will increase and then slowly decrease. This is the buffer period required for technological progress. The proportion of the tertiary industry will reach more than 60%, and the proportion of the secondary industry will not be lower than 30%.

| Table 3. Industrial energy consumption and industrial structure under policy scenario |
|-----------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|                                   | 2005              | 2010              | 2015              | 2020              | 2025              | 2030              | 2040              | 2050              |
| Primary industry energy consumption | 1550              | 1657              | 1535              | 1477              | 1368              | 1181              | 964              | 650              |
| Secondary industry energy consumption | 14901             | 16865             | 22769             | 29409             | 33304             | 32271             | 27580             | 19222             |
| Third industry energy consumption | 6529              | 6646              | 8185              | 10068             | 13599             | 16396             | 19017             | 22763             |
| Primary industry ratio/%          | 7                 | 6                 | 5                 | 4                 | 3                 | 2                 | 2                 | 2                 |
| Second industry ratio/%           | 55                | 53                | 51                | 50                | 48                | 45                | 40                | 35                |
| Third industry ratio%             | 38                | 41                | 44                | 46                | 49                | 53                | 58                | 63                |

Under the policy scenario, the proportion of the secondary industry is not less than 30%, in order to preserve the advantageous manufacturing industry in the Yangtze River Delta, as well as traditional industries such as chemical industry, increasing the proportion of tertiary production, in line with social development needs. In the adjustment of industrial structure, change the energy structure. For example, the manufacturing industry no longer uses coal as the main energy source, and it is changed to clean electric power or natural gas, etc., shut down enterprises that do not meet environmental protection standards, and let enterprises that adapt to changes meet the rules., retaining superior enterprises and advantageous industrial chains.

3. Conclusion
The Yangtze River Delta has introduced many strong emission reduction policies. Although some cities have set carbon emission peak targets, the time points are still conservative and may need to be further revised in the future. For a long time, many cities have adopted energy structures such as coal and oil. The same high-carbon energy, but due to the huge and rigid energy demand of urbanization
and industrialization, or limited by the lack of renewable energy endowment and limited development capacity, the energy supply system can not get rid of the high carbon pattern in the short term. Leading to the promotion of carbon emissions is more difficult. Therefore, in light of the economic and social development situation, we should continuously strengthen the binding and leading role of low-carbon development goals, and accelerate the formation of a green and low-carbon transformation mechanism and development model.

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